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CARE AND MAINTENANCE OF THE COMMON VAMPIRE IN CAPTIVITY

BY WILLIAM A. WIMSATT AND ANTHONY GUERRIERE

ABSTRACT: Conditions and procedures which have been utilized in our laboratory in the successful maintenance of the common vampire bat, *Desmodus rotundus*, in captivity over a period of several years are described, with the expectation that they may prove useful to other investigators. Also described is a cage design which helps minimize some of the special problems associated with the handling of vampires and making provision for their sanitation; the cage can also be used to advantage with other species of bats.

The true vampire bats of the American tropics have long held a special fascination for zoologists and laymen alike, for they are the only extant mammals to have evolved a wholly hematophagous habit. The development of such a habit in a small mammal which typically preys upon far larger ones (with its attendant hazards to the predator) almost certainly has been an important factor in the evolution of those special behavioral and nervous functions which distinguish vampires from all other bats (Wimsatt, 1959*a*). It has led also to the striking anatomical modifications of the alimentary tract which appear so beautifully adapted to the prehension and utilization of a sanguine diet (Huxley, 1865; Robin, 1881; Mann, 1950; DiSanto, 1960).

Most fundamental aspects of the biology of vampires still remain uninvestigated. In an attempt to enrich our knowledge of these bats we have undertaken various studies regarding their biology with the present emphasis on feeding behavior and the anatomy and physiology of the digestive system. Our previously published work on *Desmodus* has dealt with various aspects of the reproductive physiology (Wimsatt and Trapido, 1952; Wimsatt, 1954), behavioral characteristics (Wimsatt, 1959*b*) and the anatomy and histochemistry of the salivary glands (DiSanto, 1960). This report is the first of a series describing additional aspects of the biology of the common vampire bat, *Desmodus rotundus murinus*.

Interest in the adaptations of the Chiroptera has grown rapidly in recent years, and an increasing number of laboratories are concerned with the problem of maintaining bats in captivity for experimental purposes. We now have considerable experience with the maintenance of vampires, and since we have received a number of requests for information concerning their care, it was felt

that publication of the conditions and procedures we have used successfully might prove helpful. *Desmodus* is probably the easiest of all bats to maintain in the laboratory, owing largely to the simplicity of its diet, but due also to its intelligence and "psychological" adaptiveness. Nevertheless, there are certain refinements of maintenance and cage design which greatly facilitate the care and handling of these exceedingly agile animals.

GENERAL MAINTENANCE PROCEDURES

Our vampire colony consists of two populations, a dozen animals collected in Panama in 1952 and brought to this laboratory by Donald R. Griffin (seven of these original animals still survive), and 200 bats collected in the Mexican states of Morelos, Guerrero and Vera Cruz during the summers of 1957, 1958 and 1959, and air-shipped to Ithaca. Nearly all of these not killed for specific purposes still live, and remain in excellent physical condition. The adequacy of our maintenance program is further attested by the fact that many of these bats are breeding, and successfully rearing their young in captivity.

Temperature, humidity and light.—Our vampires are housed in specially designed aluminum cages. The cages are maintained in an air-conditioned room held between 70 and 78°F throughout the year, and with the relative humidity between 30 and 65 per cent. The animals readily tolerate higher humidities and short exposures to lower temperatures, but their tolerance of temperatures above 80°F is not good. The range 70–80°F appears optimal and accords well with temperatures recorded at natural roosting places.

During the day the room receives direct low-intensity illumination through two glass brick windows and the glass panel of an outside door. The cage design is such as to reduce this minimal light still further, but not exclude it altogether. Lights are turned on within the room only briefly when it is being cleaned, or when the animals are being attended. No effort is made to maintain the bats in total darkness, for in the field vampires were frequently found in roosts receiving low-intensity illumination during the day—indeed, often more light than that to which our caged animals are exposed.

Food and water.—As far as is known, *Desmodus* subsists wholly on blood; attempts to induce starved animals to eat solids such as hamburger were entirely unsuccessful. They readily feed upon the blood of small mammals introduced into their cages, or larger animals when free in a room with them, but these are obviously not convenient ways to provide for the nutrition of a vigorous colony of any size. Fortunately, the bats quickly learn to take blood from an open dish, and have no difficulty in feeding from fingerbowls with sides 1½ to 2 inches high.

The bats are fed once daily, usually in late afternoon, on a diet of defibrinated beef blood obtained from a nearby slaughterhouse; the soiled bowls are removed and washed each morning. Blood is obtained twice weekly and stored at 2–5°C. It remains usable, and apparently palatable, for a week, but thereafter the bats' interest in it steadily declines. We have also successfully used frozen blood, but it spoils rapidly after thawing. In the field, where fresh blood is usually hard to

obtain, we have successfully maintained vampires for several days on "instant blood" (shell-frozen and lyophilized whole defibrinated blood) reconstituted as needed with water (a method suggested by Walter Nelson of the Department of Biochemistry, Cornell University). This dry, easily soluble material is good as an emergency ration, if the supply of fresh blood temporarily fails. We feed beef blood because it is most easily obtained in sufficient quantity, and it sediments very slowly. Horse blood is readily eaten, but it sediments so rapidly when standing in a bowl that the bats often do not get a balanced mixture of plasma and formed elements unless fed from a shallow dish. Indeed, the bloods of most of the common laboratory and domesticated mammals, except carnivores, have been tried at one time or another, and all have been readily accepted.

We have made no effort to determine how long vampires might survive without food. We routinely skip feeding them on Sundays, and on a few occasions have neglected to feed individuals for as long as three days—resulting in marked emaciation, but not death.

It came as a surprise to learn that our captive vampires drank little, if any, water. We initially kept open bowls of water in the cages at all times, but it remained virtually untouched, even by animals which had missed a day's feeding; for nearly two years we have ceased to offer it, with no ill effects. It is evident that the fluid plasma adequately fulfills the vampires' water requirements. Whether they take water in the wild is unknown.

Exercise.—Space restrictions have prevented maintaining our vampires under conditions permitting voluntary flight exercise. Our special cages are 18- or 20-inch dimensions over-all, and we house up to 20 bats in each. The animals leap about inside with great agility, but have no room to fly. Bats which occasionally escape into the room seem still able to fly vigorously, even after several years, but whether they are capable of sustained flight we do not know. We recognize that maintenance of vampires free in a room big enough to permit free flight might be more desirable from a physiological standpoint, but our animals seem normally healthy and vigorous in the absence of such exercise.

Ectoparasites.—Fresh-caught vampires, like most other wild bats, are usually heavily infested with ectoparasites of several kinds, but these disappear spontaneously from the caged animals over a period of several weeks. We have not, therefore, been required to use chemical disinfectants on the animals. Perhaps the isolation from the native bat population, or the artificial environment to which the bats themselves adapt readily, creates in some way an unfavorable environment for their ectoparasites.

Care of young.—Vampire bats are a pugnacious lot, especially when crowded together in close quarters. Too frequently young animals born in the colony are bitten by the older animals and killed. Since this seldom happens to the very young animals, which remain attached to their mothers most of the time, but only to those that are more mobile, though still unweaned, it seems possible that indiscriminate probing for a nursing site with the wrong adults may cause annoyance and provoke attack. To cope with this problem we have initiated the prac-

tice of isolating pregnant or nursing females, placing them individually in small cages until their young have been weaned and are approximately two-thirds adult size, after which they may be returned safely to the colony.

SPECIAL CAGE DESIGN

Initially, we kept our vampires in almost any kind of cage which was handy, as we still do when only one or two bats are separated from the colony for special purposes. When the colony was increased in size, it became apparent that conventional cage designs are not adapted for the convenient care and handling of numbers of vampires. Therefore, a cage was devised which minimizes the difficulties involved. The major problems center about vampires' behavioral reactions when disturbed, and the special sanitary problems inherent in the character of their excrement.

When individually pampered, vampires tame readily and can be approached and handled without difficulty, but without this special attention they retain in large measure their naturally suspicious and aggressive nature. Any overt move to catch them results in violent attempts to escape and, being heavy-bodied, they sometimes damage themselves in the process; if there are many in a single cage, all behaving in this fashion, the result is pandemonium. Furthermore, when caught, they invariably bite viciously; leather gloves should always be worn in handling any but the fully tamed animals. Our special cage design permits the transfer of animals from cage to cage without the necessity of actually handling

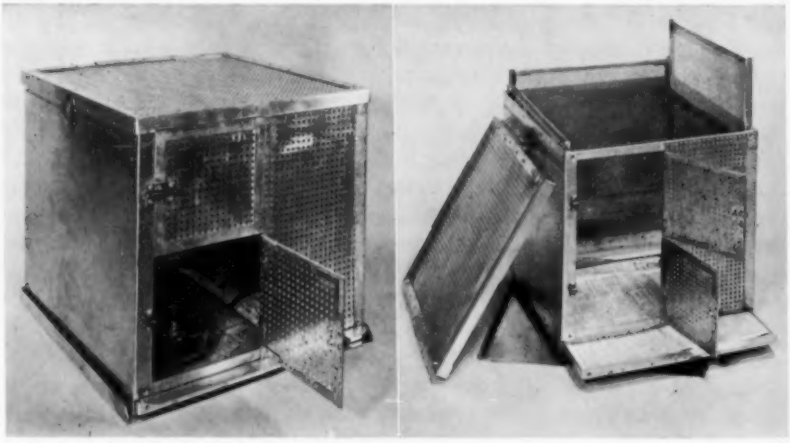

PLATE I

A cage especially designed to house vampire bats. LEFT: Fully assembled with the lower door panel opened to display the feeding bowl resting on the floor tray. RIGHT: Partially disassembled, as it would be for cleaning, consisting of seven separate components. The entire structure, except the "hardware," is made of aluminum.

them, and virtually eliminates the violent reactions which accompany attempted manipulations of bats between cages of conventional design.

Sanitation is a special problem with vampires owing to the abundance, viscosity, tar-like character and general adhesiveness of their malodorous feces. Likewise, urine is copious, and the urine and feces in combination have a remarkably corrosive effect on some metal surfaces. Wood is generally unsuitable because it becomes quickly impregnated and defiled and does not stand up well to repeated soakings and scrubbings in hot water and detergents. We have found that aluminum resists the corrosive effects of the excreta, is light, and can be soaked and scrubbed repeatedly, so our cages are completely fabricated of this material.

The special cage assembly is depicted photographically in Plate I; details of structure are shown in Fig. 1. The special advantages of this design may be summarized as follows: (1) The cage is rapidly and easily disassembled into seven separate components, facilitating cleaning and sterilization. (2) The split "Dutch doors" allow insertion and removal of feeding bowls through the lower panel without disturbing the bats, which typically hang at the top of the cage.

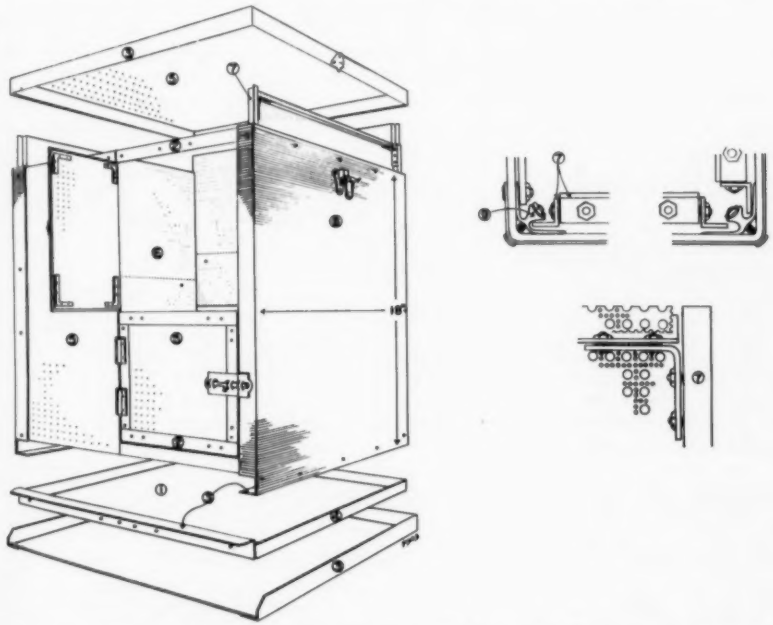

FIG. 1.—An exploded diagram showing structural details of the cage. Circled numbers indicate the materials specifications, as follows: *1*, Reynolds Aluminum (RA) item 1; *2*, RA item 4; *3*, RA item 6; *4*, RA item 7; *5*, RA item 32; *6*, RA item 33; *7*, ½ × ½ × 1/16 in. aluminum angle; *8*, aluminum sheet, 18 gauge ("fluted" pattern, design No. 10); *9*, aluminum "inside corner."

Inspection of the bats within, or the capture of individuals when desired, is effected through the upper panel, with the lower panel closed. To appreciate this feature, one needs only to leave both panels open and try to catch a bat within—he will usually spend some time thereafter pursuing several extremely agile animals about the laboratory! (3) Transfer of a group of animals from a soiled cage to a clean one is easily accomplished by a "stacking" procedure as follows: The soiled cage containing the bats is carefully inverted so that it rests on its lid. A clean cage is lifted from its tray, its sliding floor pan is removed, and with its bottom thus opened it is placed, bottom side down, on the bottom of the inverted cage below. The floor tray of the lower cage is then removed, thereby eliminating the remaining barrier between the interiors of the two cages. The vampires usually ascend into the upper cage immediately, and any laggards are easily prodded to do so through the door panels of the lower cage. The floor tray of the upper cage is slid back into place and the clean cage, which now confines the bats, can be safely returned to its tray. (4) The sides and back of the cage are provided with wall panels of perforated aluminum on which the bats hang. These may be removed by sliding in and out from the top when the cage cover is removed. The inner faces of these overhang, by about ¾ inch, the angle between the bottom and sides of the floor tray. This assures that excreta do not lodge between the wall of the floor pan and the outer cage wall (thereby jamming the floor pan) and also that most of it lands on the floor papers in the pan, for these too undercut the inner wall surfaces on which the bats are hanging; soiling of the metal floor pan is thus minimized. (5) The front and top panels of the cages are fabricated of perforated aluminum (Plate I); this assures adequate ventilation and at the same time reduces the amount of light entering.

It is obvious that a cage of this design is suitable for housing other kinds of bats than vampires, and it is especially recommended for those which are particularly shy, agile, or of aggressive temperament.

ACKNOWLEDGMENTS

We are indebted to the following people, for without their generous cooperation this and other studies on vampires could not have been undertaken. Bernardo Villa R., of the National University of Mexico, provided invaluable guidance and assistance in the field, and both he and Amelia Samano-Bishop of the same institution generously extended to the senior author the unrestricted use of their laboratories during each of his trips to Mexico. Ing. Luis Macias Arellano, of the Direccion General de Caza, authorized collecting privileges in Mexico and extended the fullest cooperation of his department at all times. We are also grateful to Philip Krutzsch for editorial comment on the manuscript. The diagram of Fig. 1 is the work of Mrs. Paula DiSanto Bensadoun.

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Dept. of Zoology, Cornell Univ., Ithaca, New York. Received 13 March 1961.

HOME RANGE AND HABITATS OF THE WANDERING SHREW

BY LLOYD G. INGLES

ABSTRACT: The home range and habitats of 11 marked wandering shrews, *Sorex vagrans*, were studied on 1.27 acres near Huntington Lake, California. Individual shrews were captured from 2 to 35 times (avg 13) over three summer months. The minimal home range and the longest distance across the range were obtained for each shrew. Of the 143 captures, 95% were in the *Salix-Scirpus* habitat. The minimal home range varied from 260 to 6,758 square feet (avg 4,000). The longest axes across the home ranges varied from 47 to 195 feet. Mature shrews have larger home ranges than do immature shrews. The frequency of captures corresponds closely with activity peaks of captive animals. There is evidence that the size, shape and the part of the home range used varies with age and season.

Although considerable work has been done in recent years on the biology of shrews, the study of their home ranges and habitats seems to have been entirely neglected. The present paper deals with the home range and habitats of the wandering shrew, *Sorex vagrans*, on a *cienega* of 1.27 acres in the red fir community at 7,000 feet altitude near Huntington Lake, California, in the summer of 1960 (Plate I, Fig. 1).

Many writers have associated this shrew with wet environments, but none has studied the sizes of the populations occurring in the different habitats (Clothier, 1955; Dalquest, 1948; Jackson, 1928; Jameson, 1955).

The area studied, which is 400 feet long by 150 feet wide (Fig. 1), extends in a north-south direction. The plot includes three distinct habitats: (1) at the outer edge of the area, occupying .22 acre, is the dry litter-covered forest floor beneath red firs (*Abies magnifica*), white firs (*Abies concolor*) and Jeffrey pines (*Pinus jeffreyi*); (2) the wet meadow habitat, occupying .35 acre, is densely covered with such plants as *Dodocatheon jeffreyi*, *Mimulus guttatus*, *Carex feta*, *Glyceria elata*, *Lotus oblongifolius*, *Trifolium wormskioldii*, *Perderidia parrishii*, and *Phalacroseris bolanderi*; and (3) the very wet central habitat, occupying .7 acre, is densely covered with willows (*Salix* sp.) and a tall sedge

(*Scirpus microcarpus*); a few *Oxypolis occidentalis*, *Heracleum lanatum*, and *Allium validum* grow on this part of the area.

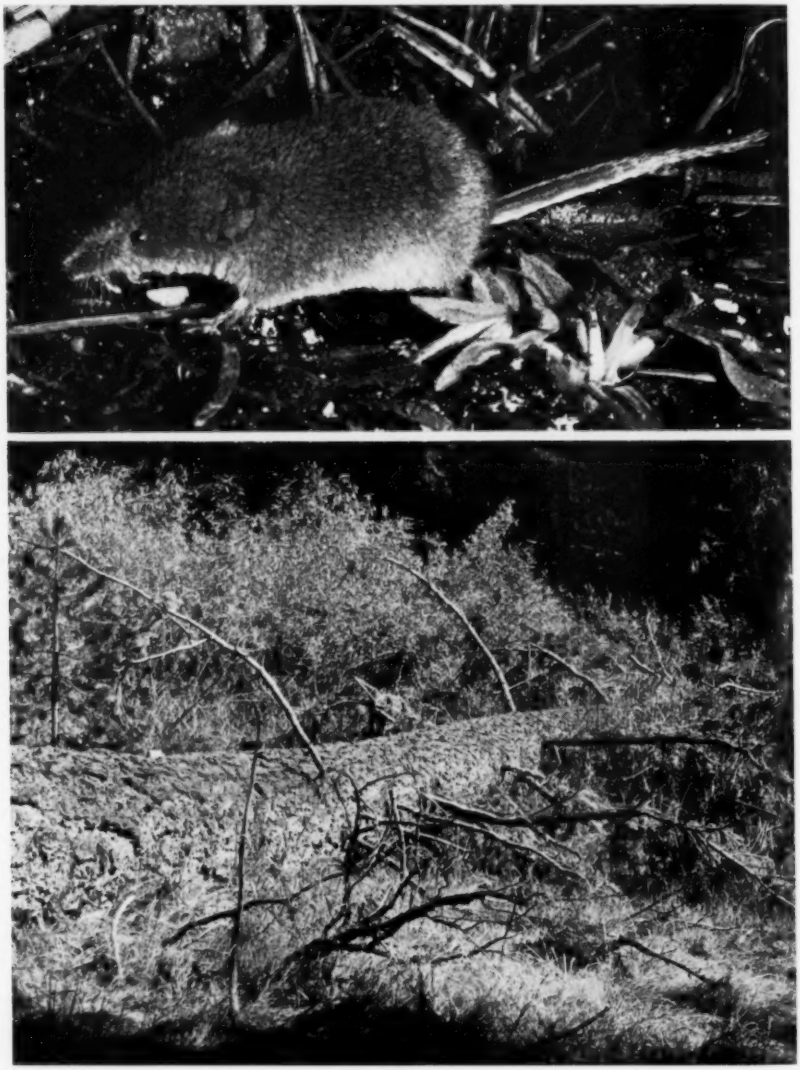

PLATE I

ABOVE: A wandering shrew photographed in its native habitat with aid of a speed light. BELOW: The *Salix-Scirpus* habitat (across the log), the meadow habitat (right foreground), and the forest-floor habitat (in distance). Photos by author.

Shrews are rare or absent in the surrounding forest in summer. Observation and trapping in the summer months for 13 years have yielded but three shrews under logs in the woods. These logs extend nearly down to the meadow. In summer, shrews rarely invade the meadow except where logs cross it.

The *Salix-Scirpus* thicket has a small but permanent stream that oozes over the surface of most of the habitat. During heavy winters, snow may accumulate up to 15 feet deep over the area and permanently bend many of the willows nearly to the ground. After killing frosts, the sedges and willow leaves fall over the reclining willows to form a thick mat of dead vegetation. It is in this mat, which may be wet or quite dry depending on its height above the ground, that great numbers of annelids, mollusks, arachnids and insects pass the winter. Two species of meadow mice, *Microtus longicaudus* and *M. montanus*, lived on the area and were sometimes trapped. These were released at the site of capture.

I wish to express my gratitude to Charles Quibell for the identification of the plants and to John Crosby for drawing the maps.

METHODS

This study was begun on 10 June and ended on 10 September 1960. Because of the dense and tangled nature of the *Salix-Scirpus* habitat, it was decided that precise quadrat- or grid-trapping would not be suitable. Many of the advantages of quadrat-trapping would be nullified by the modification in the vegetation that would accrue. Other disadvantages of the grid method of survey which apply to this area have been described (Murray, 1957).

The area was carefully mapped by narrow east-west paths 20 feet apart, made with as little disturbance as possible to the vegetation. Other landmarks, especially fallen logs, were used not only to facilitate trapping but also to assist in locating each capture accurately on the map. Twenty No. 1 Sherman folding live traps were set in likely places along the paths from 5 to 15 feet apart and along the fallen logs. Bait boxes, made from the lower inch of paraffin milk cartons, were also scattered widely along the paths. These were baited frequently with a few flakes of oatmeal. When shrew scats began to appear in a bait box, a trap was then substituted for the box. In this way the traps were kept set in the most likely places. The traps were visited every two hours, mostly between 6 AM and 8 PM. They were set daily except during the first three weeks in August. Trapping was resumed on 22 August. The procedure was to trap a small area intensively for two days; the traps were then washed in hot water and moved to a new location. When an animal was caught, the trap that caught it was always moved to a new location. Traps were never set at sites that had been previously trapped. The traps were baited with a mixture of peanut butter and oatmeal. When an unmarked shrew was caught, special efforts were made to discover its range as rapidly as possible by locating traps in nearby places where it might be expected to be taken again. No special efforts were made to recapture an animal after five captures.

The animals were marked for identification by clipping off the fur to form

various patterns on different parts of the body. These markings were clearly identifiable at the end of the study.

To ascertain whether the odor of feces and urine of one shrew might repel another shrew, bait boxes containing feces and urine of a particular animal were taken to the home range of another after a layer of rolled oats had been used to cover the excrement in the box.

No attempt was made to determine the sex of the animals captured.

The time of day was recorded for each capture in order to compare the activity at various times of the day with that of captive shrews.

The boundary-strip method of determining size of home range by grid-trapping was found by Stickel (1954) to give sizes closer to the true home range in artificial populations than the minimum area or the observed range length. However, because the traps in this study were not set on a grid, it was decided to use the minimal home range (Hayne, 1949) which was calculated for each animal (except No. 9) and also the observed range length for each shrew.

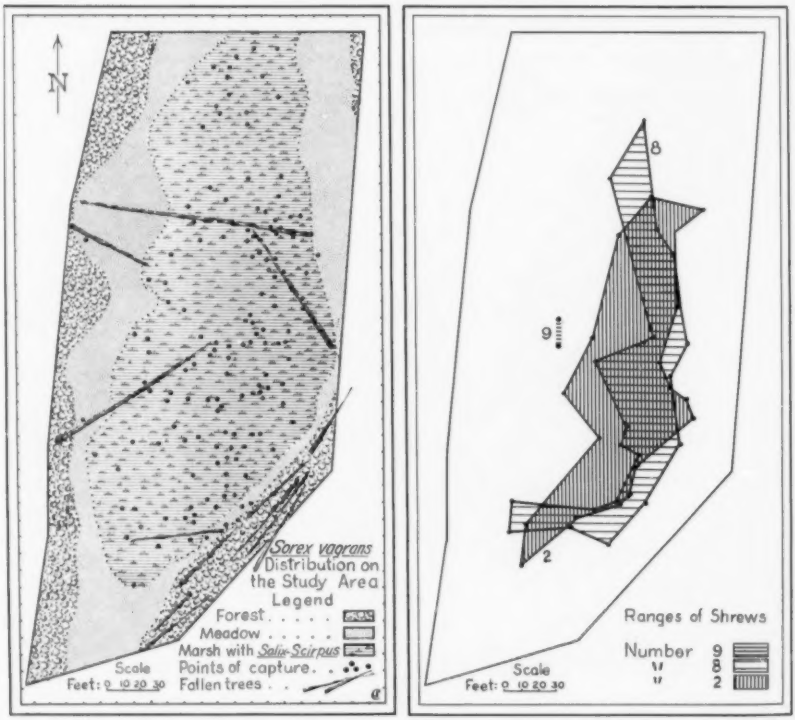

FIG. 1.—Map of the study area, with types of habitat and points of capture of shrews (left) and home ranges of three individual shrews (right).

RESULTS

Eleven shrews were trapped in the area. The number of captures for each shrew ranged from 2 to 35, with an average of 13. After being caught once, most shrews readily entered other traps. Two shrews were each caught three times on the day of their first capture. Four others were captured four or more times in one day. The area was trapped for a total of 7,620 trap-hours.

Most animals were captured under the thick mat of dead vegetation in the wet *Salix-Scirpus* habitat (Plate I, Fig. 1); rarely was one taken in the meadow and never in the dry litter of the forest floor (during this study). More species and individuals of small mollusks, earthworms, insects and arachnids, known to be used as food by these shrews, are found per square yard in the *Salix-Scirpus* habitat than in the surrounding meadow or forest. Potential predators observed on the area included a sparrow hawk (*Falco sparverius*), a pigmy owl (*Glaucidium gnoma*), Steller jays (*Cyanocitta stelleri*), Clark nutcrackers (*Nucifraga columbiana*), a garter snake (*Thamnophis* sp.) and a rubber boa (*Charina bottae*).

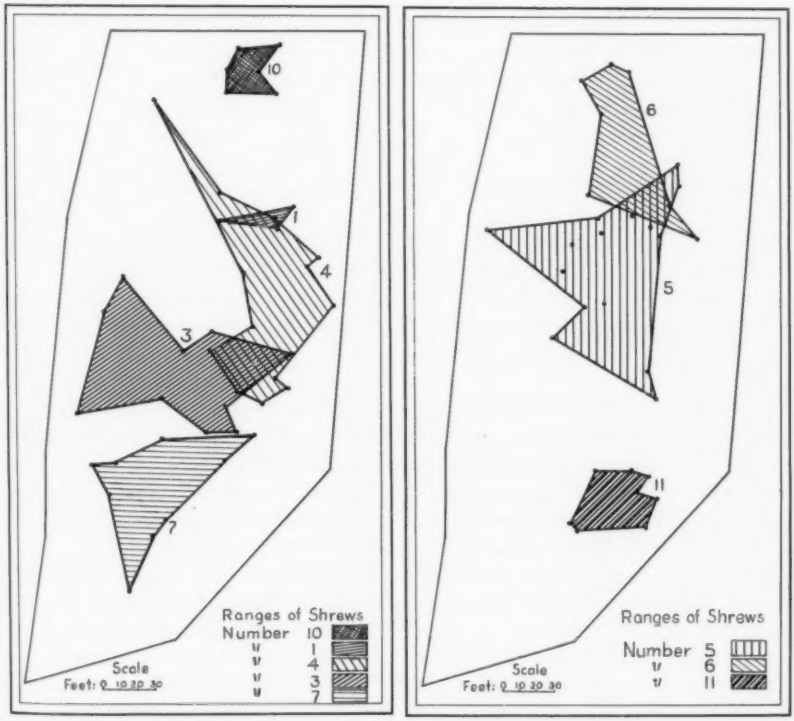

FIG. 2.—Home ranges of eight shrews on the study area.

TABLE 1.—*Data on 11 wandering shrews captured*

Shrew No.	No. of captures	Minimum home range, sq ft	Longest axis across home range, ft	First and last captures
1	5	260	47	5 July 16 July
2	35	8,964	240	6 July 9 Sept.
3	12	3,992	136	8 July 7 Sept.
4	17	5,276	195	8 July 2 Sept.
5	13	6,528	144	11 July 28 Aug.
6	11	2,900	116	16 July 28 Aug.
7	9	3,360	124	17 July 9 Sept.
8	23	6,758	255	9 July 10 Sept.
9	2	—	16	22 July 22 July
10	7	638	40	22 Aug. 23 Aug.
11	9	1,324	55	5 Sept. 8 Sept.

After 4 hours, shrews did not hesitate to enter bait boxes which contained the recently voided feces and urine of other shrews.

Seven of the nine shrews, captured before 1 August, were recaptured at least once in the traps between 22 August and 10 September. The average size of the home ranges which could be calculated was 4,000 square feet. The minimal home ranges vary greatly in shape and size and overlap considerably (Figs. 1, 2).

Data pertaining to home ranges of the 11 shrews are shown in Table 1 and Figs. 1 and 2.

Clothier (1955) found another subspecies of this shrew to average 4.74 grams until reproductive activity began, after which the weight increased to an average of 7.2 grams. Shrews No. 2 and 8 weighed about one-third more than the other shrews and their pelage was longer, more lax and irregular. These two shrews are considered to be mature and to have been born in 1959; the rest are considered to be immature and were probably born in the spring of 1960.

All but 5 per cent of the captures were made within the *Salix-Scirpus* habitat. The remaining captures were in the surrounding meadow but only where logs or tall grasses formed a protective cover. Wet parts of these habitats contained no shrews, even though food was plentiful, if the cover was meager. Neither trapping nor bait boxes indicated the presence of shrews under the logs or in the litter of the forest floor, although shrews are known to occupy this habitat occasionally after the snow melts in late spring.

The frequency of captures at different times of the day corresponded very closely to the activity peaks found by Ingles (1960) for captive shrews during the daylight hours.

Although special efforts were made to catch No. 1 and 9 after 22 August, they were never taken.

The two mature shrews (No. 2 and 8) were trapped widely over the *Salix-Scirpus* habitat. Their home ranges largely cover the same area and, except for No. 9 and 10 which lie at the edge of the habitat, they include all or a part of the home ranges of the immature shrews. The longest axis across the lesser of the home ranges of the mature shrews is 23 per cent greater than the longest axis across the home range of any immature animal. Hayne (1949) pointed out that parts of the home range may be more intensively used than others. There may also be more or less permanent shifting of the outline of the area.

After 2 months, some of the immature shrews which were taken 100 feet or more from the site of their first capture could not be taken again near the site of their original capture.

DISCUSSION

The *Salix-Scirpus* habitat provides not only a better and more continuous source of food, but also better protection from potential predators. The relatively greater diurnal and nocturnal activity of wandering shrews exposes them to a larger variety of predators for a relatively longer time each day than any other small mammals inhabiting the area (Ingles, 1960). Better cover in the *Salix-Scirpus* habitat is thought to explain why shrews are rarely found in the summer months in the meadow, where there is little protective litter although food is sufficient.

Only two shrews (No. 1 and 9) are believed to have disappeared from the area during the study. The number of captures of the rest (avg 13) probably gives a fairly accurate picture of their home ranges. Where comparable results have not been obtained in other studies, the discrepancy may be due to too few captures or too great an interval between captures. In the latter case, the home range may actually be much smaller than indicated.

It appears that the "ameboid" outlines and sizes of the home ranges do shift and vary with age and seasons (Burt, 1943). As summer approaches and much more food becomes available the mature shrews continue to wander over their winter-spring home ranges, in which the immature shrews have already established their own shifting home ranges. At this altitude, there is no evidence that this species reproduces during the summer or autumn months. These shrews rarely live more than 16 months (Rudd, 1955). It therefore seems that the mature shrews would not be important competitors for food with the onset of winter, since most of them would be dead.

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A NEW METHOD FOR MEASURING HOME RANGES OF SMALL MAMMALS

BY KEITH E. JUSTICE

ABSTRACT: The movements of individually toe-marked wild *Mus musculus* were detected by tracking the mice on smoked kymograph paper. The smoked paper was placed in unbaited half-gallon milk-carton or coffee-can shelters arranged in a dense rectangular grid. As many as ten records were obtained from an individual mouse in a single night. The method avoids the biases of trap inhibition, learning, and trap fatigue inherent in the mark-and-recapture method, and provides information suitable for the investigation of the theoretical probability density functions of mouse activity.

The secretiveness of most small mammals has always presented problems to those interested in studying their movements and behavior. Particularly in the case of nocturnal rodents has it been difficult to gain direct knowledge about the activity of individuals. Many schemes for obtaining information have been tried, with varied degrees of success. They include fecal dyes, mechanical-electrical sensing and recording, direct observation, radioisotope marking of individuals or feces, autophotographic recording, and mark-and-recapture. Some of these methods (fecal dyes, mechanical-electrical sensing and recording) are of limited usefulness for home-range studies because they do not ordinarily permit differentiation between individuals. Others (direct observation, radioisotope marking) are limited by operator capacity, and another (autophotographic recording) by the cost of each unit. Mark-and-recapture has been the method most frequently and successfully used to study home-range phenomena, but it

has three important disadvantages: (1) The capture of an animal prevents further movement of that animal until it has been released, thus introducing a "trap inhibition" bias to estimates of parameters; (2) there may be a strong positive or negative learning toward the experience of being trapped; (3) under continual trapping, there may be considerable trap fatigue and loss of life among animals that have been in traps night after night. All three of these factors produce an alteration of the animal's activity pattern which is quantitatively and perhaps even qualitatively difficult or impossible to valuate.

This paper describes a new method which appears to avoid the biases of the mark-and-recapture method while still providing full information on individual movements. It may also prove to be more efficient than the other methods in terms of information provided for the amount of effort and expense invested. Finally, it may provide new types of information, particularly when used in combination with some of the older methods. It should be noted, however, that the method has been tested with only one species, *Mus musculus*. Although it promises to be adaptable for use with most species of small terrestrial vertebrates, its value will no doubt vary depending on the habits of the species.

METHODS

Basically, the new method consists of tracing the movements of individually toe-marked animals by tracking them on smoked tracking boards placed at intervals in the study area. Several different tracking media were tried but none worked so well as smoked kymograph paper. The use of smoked paper was suggested by the work of Mayer (1957) and by the paper of J. A. Sealander read at the annual meeting of this Society in 1957. The paper is glued or clipped temporarily to a stiff cardboard or metal sheet to facilitate handling. The backing material used for most of the work reported here was "chip board" (a heavy cardboard) waterproofed by boiling in paraffin. However, when exposed to the sun the paraffin tends to diffuse up onto the smoked surface, ruining it. Recently, I have used sheet-metal backing with the kymograph paper clipped in place with ordinary paper fasteners. The paper is not smoked until it has been fastened to the backing. The smoke may be applied by hand with an ordinary benzene-alcohol lamp, but if extensive work is planned a kymograph smoker makes the job much easier. For this investigation an ordinary kymograph drum was modified to hold five boards 3.5 inches wide and 6 inches long. The smoked boards are transported to and from the field in a holder similar to an over-sized microscope slide box.

Shelters must be provided for the boards in the field to keep debris and dew from destroying the smoked surface. In southern Arizona, adequate protection was provided by half-gallon milk cartons with the tops cut off. If the tracking boards are 3.5 inches wide and 6 inches long, they will cover the base of the horizontal carton completely. With one end completely open, the milk cartons do not provide good protection from the rain. However, they are easy to check for tracks since the smoked paper may be examined without disturbing the

carton. During rainy periods, I have used 1-pound coffee cans, each with a small entrance hole punched in the side. If desired, a hood may be soldered to the side of the can about the opening. The coffee cans will accept tracking

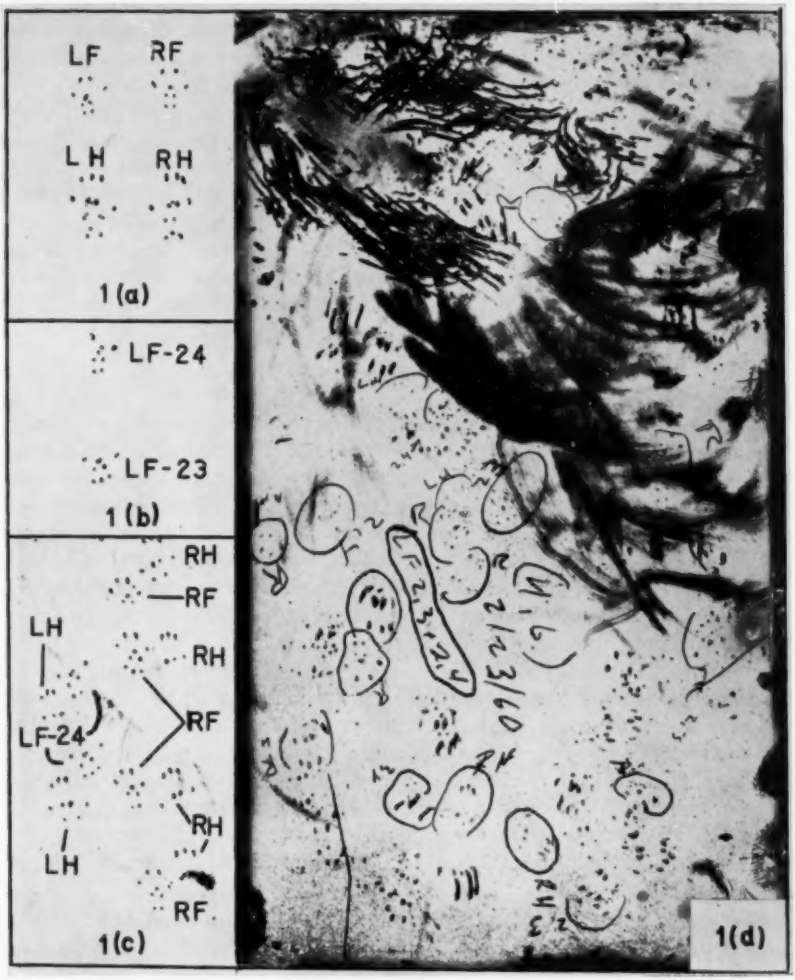

PLATE I

Negative reproduction of mouse tracks on smoked paper; (*a*) normal prints; (*b*) two marked prints; (*c*) typical sequence of prints, made by a mouse marked LF-24; (*d*) an unusual board, tracked by both a male and a female mouse. The tracks near the top of the board suggest that copulation may have taken place within the tracking shelter.

boards one-half the size of the regular boards, allowing the same smoking equipment and storage boxes to be used for both sizes if they are properly designed.

The marking system I have used for *Mus musculus* requires the clipping of a maximum of two toes on a foot, but no more than one foot is marked on any mouse. If more than one foot is marked, confusion may arise in the interpretation of some of the tracking boards. By this system, 50 different mice may be marked. While this number may be too low to allow marking the entire population of an area, it allows an adequate sampling for most purposes. For recording purposes I use RF, LF, RH, LH to denote right front, left front, right hind, and left hind feet, respectively. The medial toes are designated as (1) and consecutive numbers proceed laterally. Thus the mouse with the innermost toe on the right front foot clipped is designated by RF-1, while the mouse with the second and fourth toes on the left front foot clipped is designated by LF-24. In Plate I, (*a*) shows negative reproductions of unmarked prints of *Mus musculus*, (*b*) gives some marked prints, and (*c*) indicates the relative positions of the prints made by a mouse walking normally.

In preparation for the tracking, the area is first thoroughly live-trapped. As each animal is captured for the first time, it is assigned a toe mark and the appropriate toes are clipped off well back of the nails. Size measurements and reproductive information may also be recorded at this time. After most or all of the animals have been toe-marked, trapping is discontinued and the study area is left undisturbed for a few days in order to allow activity to return to normal. Tracking boards are then laid out in a dense grid on the study area. For *Mus musculus*, I have used spacings of 12.5 and 25 feet, but in some instances even smaller spacing may be advantageous. The density of the grid is limited only by the effort required to check the tracking stations, since the stations are not baited and apparently have no inhibiting effect on the activity of the animals. The grid is checked every day, or even less often, depending on the population density and the type of information sought. Boards which have been tracked are marked with the date and station identification directly on the smoked surface, and a fresh board is set out at the station. The boards are returned to the laboratory for interpretation. After the tracks on the boards have been identified, the smoked surface is set with a charcoal fixative spray of the type sold in art supply houses, and the papers are removed from the backing material for filing.

Identification of the mouse or mice responsible for tracking a board can be accomplished without prior experience if the board is not heavily tracked. With a little experience, the simple boards may be read at a glance, and even the heavily tracked boards require only a few minutes of examination. Occasionally, boards are so heavily tracked that they have to be listed as "unknown," but if the boards are renewed often enough, heavily tracked ones represent a small proportion of the total.

RESULTS

To date, I have used the tracking method on three different populations of *Mus musculus* living on cultivated or disturbed lands in Arizona. The preliminary

experimental work was done in a pecan orchard with a dense cover of grass. The data reported here are from the second trial, conducted in a field of winter rye. A third trial was made on a population living on the weed- and grass-covered floor of a large gully. In all three trials, the method proved workable and provided valuable information on mouse movements. This research is part of a comprehensive investigation on the population dynamics and behavior of *Mus musculus*, the results of which will be reported in detail later. The data reported here are intended only as an illustration of the method, and not as a definitive description of *M. musculus* home-range phenomena.

The field selected for investigation had been planted with rye to provide green forage for cattle. At the beginning of the study on 24 January 1959, the rye had been grazed down to a height of approximately 6 inches, and trampled to the extent that 25 to 50 per cent of the ground was bare. No cattle were present on the area during the period of investigation. At the end of the tracking session, on 24 February, the rye was approximately 12 inches high and very dense. At first, the grid of trapping and tracking stations consisted of 112 stations on a 25-foot spacing, completely filling a narrow neck of the field, as shown in Fig. 1. This grid was trapped for ten days with one small Sherman trap at each station. The traps were checked once a day in the morning. This exhaustive trapping was done to determine the status of a population previously marked on this area. None of the previously marked mice was recovered. Three new mice, one adult female and two adult males, were captured and marked.

Ten days after the cessation of trapping, on 12 February, an unbaited tracking board in a milk carton shelter was set out at each station of the grid. In addition, a line of 14 baited "coffee-can" tracking stations was set along a grassy fence row paralleling the northern boundary of the grid. The tracking boards were checked once daily for 12 days. After a few days of tracking, it became apparent that the study area was too small to include the entire home ranges of the mice. Therefore, on 18 February, 56 stations were added to the south end of the grid, and on 20 February, 28 more stations were added to the south end. The grid ultimately contained 196 stations and measured 325 feet square, covering 2.42 acres.

Of the three mice marked, only two were tracked. Perhaps the other mouse was the victim of a house cat seen hunting in the area. A female, LF-23, was tracked a total of 52 times—an average of 4.3 times, and a maximum of 10 times in one night. A male, LF-24, was tracked a total of 31 times—an average of 2.6 times, and a maximum of 10 times in one night. The results of this tracking are summarized in Fig. 1, where the number of times the mouse was tracked at each station is indicated by the size of the symbols. In interpreting this figure and Fig. 2, it must be kept in mind that the southern portions of the grid did not receive as much tracking effort as the remainder of the grid, since the grid was enlarged to the south during the course of the tracking session. No tracks were obtained from the 14 baited tracking stations along the fence row, even though

this strip of grass was separated from the rye field by only a 6-foot strip of bare ground.

The home ranges are surprisingly large, perhaps because of the low population density. The home range of the male has a maximum length of 269 feet, that of the female 331 feet. The two home ranges are almost mutually exclusive. The female trespassed into the home range of the male on a few occasions, but most

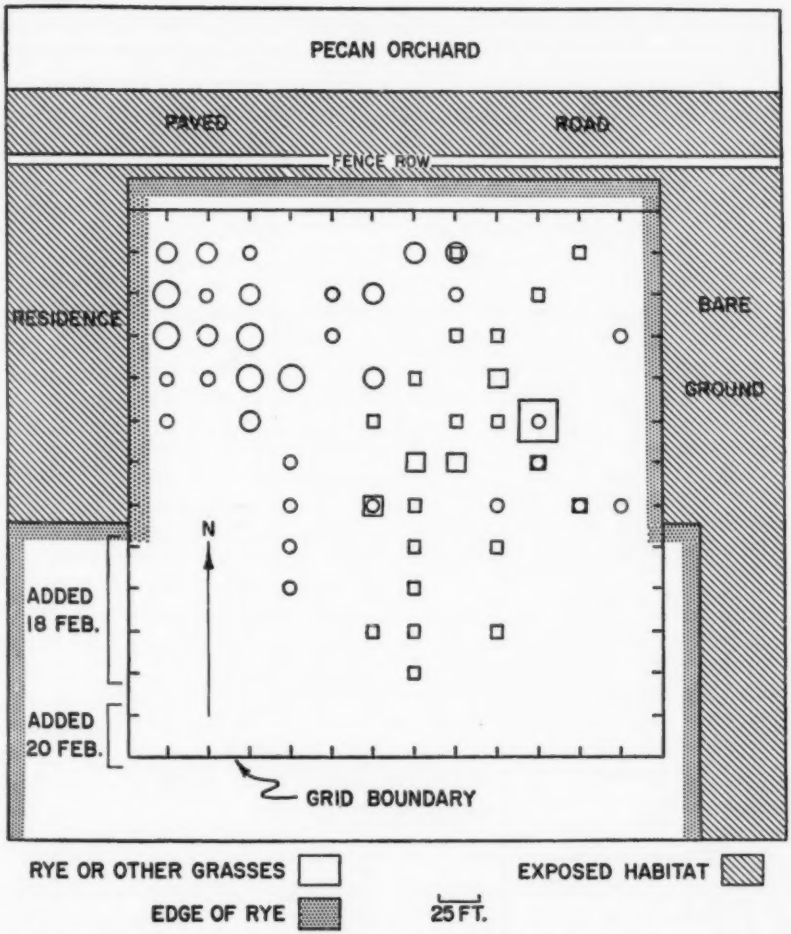

FIG. 1.—Summary of tracking results for a 12-day period. Only two mice were tracked: a male shown by squares, and a female shown by circles. Small, medium and large circles indicate tracks on one, two and three days, respectively. Small, medium and large squares indicate tracks on one, two and *four* days, respectively. (No station was tracked three times by the male.)

of these records were made on 17 February when the male was not active. This fact is shown by Fig. 2, which gives the results of each night's tracking. On 20 February, the first instance of both mice tracking the same station on the same night occurred. The female again ventured into the home range of the male on 23 February. This time the male tracked two stations in the same vicinity, one of which was tracked also by the female. This tracking board is reproduced in Plate I (*d*). Although the quality of the surface has suffered considerably in handling and fixing, the nature of the tracks still suggests that copulation may have taken place within the shelter of the milk carton. Decision as to whether this really

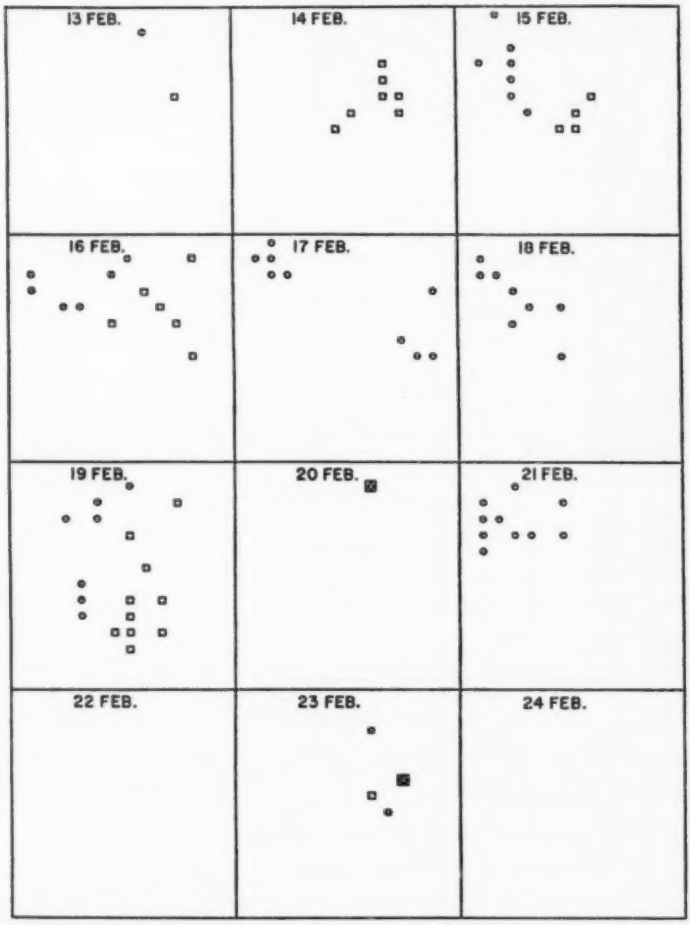

FIG. 2.—Results of each day's tracking. Stations tracked by the female shown by circles, and those tracked by the male shown by squares.

happened will have to await the accumulation of more experience in the interpretation of mouse tracks.

It can be seen from the daily maps that the stations are often tracked in groups of three or four in a north-south line. This probably results from the relationship of the grid to the "irrigation borders," that is, the ridges running the length of the field to guide the irrigation water. These ridges coincided with the north-south lines of the tracking grid; the tracking boards were placed in the shelter of the rye near the ridges. The mice probably traveled alongside these ridges in the denser cover and thus tracked stations in a linear sequence.

DISCUSSION

The example provided above is somewhat unusual in that it deals with only two individuals of a single species. Most home-range studies include a greater number of individuals and frequently involve the simultaneous study of several species. The example given was chosen precisely because it promised the least number of difficulties in presentation and illustration of the data. I have used the method on two other populations, as mentioned earlier. Both of these contained a greater number of individuals, and the method proved workable in both cases. When working with a dense population, especially where there are many young mice, there is more tendency for some boards to be so heavily tracked that individuals cannot be identified. The problem is aggravated by the presence of unmarked mice in the area. The solution is to renew the boards more frequently, to trap every few days to mark weanling mice, to use larger boards or more of them, and perhaps to modify the shelters so that the mice will not spend so much time in them. Even so, there may be an occasional board that will have to be discarded as impossible to interpret, because of heavy tracking. Experience indicates, however, that these will be a small proportion of the total in a properly executed study. In the case of the example given above, all of the 81 boards could be interpreted with little difficulty.

The only other species of rodent which has been tracked during the *Mus musculus* work is *Sigmodon hispidus*, and it was rare in the areas studied. Consequently, I can say little about the problems that may be encountered with other species. A few good cotton rat tracks were obtained, but usually the board was wiped almost clean by either feet or hair. The cotton rat is inclined to chew on the kymograph paper and apparently spends much more time in the shelter than does *Mus*. In order to track *Sigmodon*, it will probably be necessary to deposit the carbon directly on a metal plate, and perhaps also it would help to increase the area of the tracking surface.

Whenever a new method is adapted, demanding new skills, new equipment, solutions to new problems, and new techniques of analysis, the question arises: Is it worth the trouble? I am convinced that the tracking method is worth the trouble, if for no other reason than that it circumvents the three biases inherent in the mark-and-recapture method, as mentioned in the introduction. The elimination of the biases makes possible a more accurate description of home range by standard graphic techniques of analysis. It also provides information for the

investigation of the probability density function (PDF) of rodent activity in space. For this purpose the empirical frequency distribution is required, taking the form in this case of a three-dimensional histogram. Two dimensions represent the plane of activity, and the third dimension shows the frequency of activity over each subdivision (class interval) of the plane. This is essentially the information given in Fig. 1, where the third dimension is shown by the sizes of the symbols. Because the particular empirical frequency distributions determined in this investigation were influenced by edge effects of the habitat and by unequal tracking effort over the study area, no attempt was made to fit a theoretical PDF to the data. It can be seen, however, that the tracking method is capable of supplying the type of information needed. Other authors (Dice and Clark, 1954; Calhoun and Casby, 1958) have tested hypotheses concerning the theoretical probability distributions of mouse activity using available data, that is, the results of mark-and-recapture studies. As these authors have acknowledged, the data used are deficient in two respects: (1) Biases of trap inhibition and learning are probably present, and (2) the information for any one individual is so sparse that methods involving the combination of individual records must be used. The tracking method should eliminate both of these difficulties and allow a more profitable investigation of home-range phenomena with the tools of modern theoretical statistics.

The tracking method has also been found useful for surveying areas of low population density, and for detecting migration across exposed habitat where mice do not ordinarily occur. For this purpose, a line of tracking boards in baited coffee-can shelters is set out and checked for tracks about once a week. To get the same information with traps would require checking the traps once or even twice a day. When used in this manner, one man can operate 600 stations, checking only 100 each day, and thereby obtain at least the same effectiveness as a line of 600 traps.

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STANDARDIZED METHODS FOR MEASURING AND RECORDING DATA ON THE SMALLER CETACEANS

By The Committee on Marine Mammals
American Society of Mammalogists

Edited by Kenneth S. Norris
Dept. of Zoology, Univ. of California, Los Angeles

Abstract: Desirable external measurements are defined, and important natural history data relating to reproduction, food habits and parasites are listed, in an attempt to standardize the recording of this vital information for use both by cetologists and by zoologists lacking previous experience with the smaller cetaceans.

A major difficulty in using morphologic data gathered from stranded cetaceans by many widely scattered persons is that the resultant figures are seldom directly comparable. There is lack of agreement, even among some cetologists, about the definition of various external measurements, and a collective effort toward standardization has been needed. Uniformly taken measurements will, in fact, invite and suggest comparisons that cannot now be made. Consequently, the Committee on Marine Mammals of the American Society of Mammalogists, with the suggestions of several foreign authorities on the Cetacea, has prepared the following guide. It is a selected list of measurable characters, most of which have been used by field zoologists. In addition, a list of important life history data is included. These data relate to three major life history subjects: reproduction, food habits and parasitism. These measurements and data lists are general and in some special cases it will be obvious that additional information is needed. To take an extreme example, if one finds a stranded male narwhal, obviously a measurement of the elongate tusk is in order.

The list does not include measurements of the skull and appendicular skeleton, which can be obtained with greater accuracy in the laboratory. It is intended to be comparable, as directly as possible, to the best available published measurements for odontocetes and small baleen whales. It is intended both to standardize the efforts of cetologists and to help the zoologist who has had little or no previous experience with cetaceans but who wants to record information of value from the animal that has stranded on his beach. For occasions when time is limited, asterisks (*) mark those measurements and observations considered most important.

The value of these observations and measurements will be enhanced greatly by saving the skull and other skeletal parts or at least a few teeth for age determination. The importance of this skeletal material becomes obvious when one realizes that several species of dolphins and beaked whales are known *only* from skulls or skeletons. Saving the skull and appendicular skeleton sometimes can be accomplished by burial of the body (for two or three months) in the beach. Local residents will usually be anxious to help. The burial site must be marked by some accurate and indestructible means of relocating the exact position of the buried animal. When the animal is exhumed great care should be taken to

CETACEAN DATA RECORD

(Items of greatest importance starred)

*Species _____ *Date of stranding or capture _____
*Number of individuals _____ *Time of stranding or capture _____
*Sex _____ *Observer _____
*Locality _____

*Condition of specimen(s) _____
*Remarks (circumstances of stranding or capture) _____

Weight _____
Number of teeth (or baleen plates):
Right upper _____ Left upper _____
Right lower _____ Left lower _____
Diameter of largest tooth _____
*Number of throat grooves _____
*Color (indicate pattern on measurement diagram) _____

MEASUREMENTS

Body:

*1. Length, total (tip of upper jaw[1] to deepest part of notch between flukes, or middle of posterior fluke margin if no notch is present) _____
*2. Length, tip of upper jaw to center of eye _____
3. Length, tip of upper jaw to apex of melon[2] _____
*4. Length of gape (tip of upper jaw to angle of gape) _____
5. Length, tip of upper jaw to external auditory meatus _____
6. Center of eye to external auditory meatus (direct) _____
7. Center of eye to angle of gape (direct) _____
8. Center of eye to center of blowhole(s) (direct) _____
*9. Length, tip of upper jaw to blowhole along midline, or to midlength[3] of two blowholes _____
*10. Length, tip of upper jaw to anterior insertion of flipper _____
*11. Length, tip of upper jaw to tip of dorsal fin _____
12. Length, tip of upper jaw to midpoint of umbilicus _____
13. Length, tip of upper jaw to midpoint of genital aperture _____
*14. Length, tip of upper jaw to center of anus _____
15. Projection of lower jaw beyond upper (if reverse, so state) _____

[1] "Tip of upper jaw" is a convention meaning anteriormost point on animal's head (excluding lower jaw). Usually this is the tip of the beak, but in the sperm whale, pygmy sperm whale, adult pilot whale, etc., it is not.

[2] The word "melon" is a whaler's term used to describe the fatty protuberance of the foreheads of many whales and porpoises.

[3] Midpoint of the length.

16. Length, tip of upper jaw to posterior extremity of throat creases _____
17. Thickness of blubber, mid-dorsal at anterior insertion of dorsal fin _____
18. Thickness of blubber, mid-lateral at midlength _____
19. Thickness of blubber, mid-ventral at midlength _____
20. Length, throat creases: maximum _____, minimum _____
21. Girth, on a transverse plane intersecting axilla _____
*22. Girth, maximum (describe location as distance from tip of upper jaw) _____
23. Girth, on a transverse plane intersecting the anus _____

Apertures:

24. Dimensions of eye: height _____, length _____
25. Length, mammary slits: right _____, left _____
26. Length, genital slit _____, anal opening _____
27. Dimensions of blowhole(s): width _____, length(s) _____
28. Diameter of external auditory meatus:
right _____, left _____, absent _____

Appendages:

*29. Length, flipper (anterior insertion to tip) _____
*30. Length, flipper (axilla to tip) _____
*31. Width, flipper (maximum) _____
*32. Height, dorsal fin (fin tip to base) _____
33. Length, dorsal fin base _____
*34. Width, flukes (tip to tip) _____
35. Distance from nearest point on anterior border of flukes to notch _____
*36. Depth of notch between flukes (if none, so state) _____

LIFE HISTORY DATA

*External parasites (describe location) _____

*Internal parasites:

Nasal passages _____ Air sinuses _____ Stomach _____
Intestine _____ Blubber _____ Kidney _____
Other _____

*Stomach contents (preserve in 10% formalin, if possible) _____

*Reproduction (female):

	Ovaries	
	left	right
Follicles, largest diameter:	_____	_____
Active corpora lutea (no.):	_____	_____
Scars of corpora albicantia (no.):	_____	_____

Foetus, length _____, sex _____
Milk in mammary glands: much _____, some _____, none _____

*Reproduction (male):

	Testes	
	left	right
Dimensions:	——×——	——×——
Weight:	_____	_____

Sperm in cut epididymis: present _____, absent _____

Preserve in 10% formalin: both ovaries; any small foetus; 1-cm cubes of mammary glands or testes.

recover all loose teeth and the pelvic rudiments. These latter bones are located just above the anal opening in the intact animal.

Great opportunities lie virtually unexploited in the investigation of mass strandings. The person who can organize a team of helpers to record observations from a stranded school of pilot whales, false killer whales, etc., may discover a great deal that no previous investigator could guess.

MEASUREMENTS

All measurements, except girths, should be taken in *straight lines*, and not over the curvature of the body. All length measurements from the tip of the snout should be taken parallel to the longitudinal axis of the body.[1] A measuring tape or rule is essential, and a length of twine will help in obtaining these measurements. For measurements to be made from tip of snout, a straight, slender rod may be held at the tip of the snout and, within the plane that is perpendicular to the long axis of the animal, maneuvered just as needed to measure with a tape or rule from the rod to each point on the body. For measurements to be made from tail notch, a rod may be held in the notch and maneuvered in a plane perpendicular to the long axis of the animal just as individual measurements may require. For measuring from tip of snout to notch of tail, one should employ two rods.

In this list the tip of the upper jaw (or anteriormost point on the head, as in the case of sperm, pygmy sperm, and most adult pilot whales) is taken as the reference point for all major longitudinal measurements but, if the snout is too badly damaged, all the same points on the body should be measured from the fluke notch.

Taxonomists will recognize that some linear non-axial measurements are desirable. For example, distance from eye to corner of mouth or blowhole may occasionally prove diagnostic of a species or genus. In Fig. 1, the distance from the eye to the blowhole better illustrates the point. The axial distance from eye to blowhole is measurement 8 minus measurement 2. Direct measurement between the middle of the eye and the middle of the blowhole is obviously much longer. This particular direct measurement is rather difficult to take because of the curvature of the head, but if the investigator suspects that a direct measurement may be important he should take it. *Length* and *width of flipper* are less troublesome examples of direct measurements. The important point is that an observer who uses such measurements as eye to ear, eye to corner of gape, ear to blowhole, etc., should be certain to label these measurements as either *direct* or *axial*.

The measurement *dorsal fin base* (33) is subjective, but together with the height of the fin, gives a gross idea of the size of the fin. The shape of the fin can be recorded adequately with a photograph or an outline tracing of its profile.

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[1] Measurements of large baleen and sperm whales are most conveniently taken as direct lines and not as measurements parallel to the major body axis. This practice is already so widely used that we do not recommend extension of our criteria to use aboard whaling vessels or in other situations where large commercial species are concerned. For example, such direct measurements have been taken by the Japanese Whales Research Institute, C.S.I.R.O. in Australia, and the Discovery Committee.

PHOTOGRAPHS

Good photographs, preferably in color, often are valuable. There are several recommended views. The most important is a lateral view of the entire animal. Dorsal and ventral views of the whole animal are also extremely valuable. These three poses should be recorded at right angles to mid-body. Close-up views of the head, dorsal fin, a ventral view of the genitalia, and both dorsal and ventral views of the flippers and flukes are recommended. Photographs of any prominent scars or abnormalities are also useful.

WEIGHTS

Very few weights have been recorded for cetaceans. Where facilities are available weights should be obtained, if at all possible and if the condition of the animal warrants the attempt. Special effort, even to dividing the carcass into weighable sections, should be made to obtain this information.

The general state of decomposition of an animal and its nutritional state are important data because both bear upon the accuracy of such measurements as girth and blubber thickness, as well as upon weight.

FOOD

No detailed food analysis can be made in the field since accurate determinations will usually depend upon such material as disarticulated fish vertebrae and

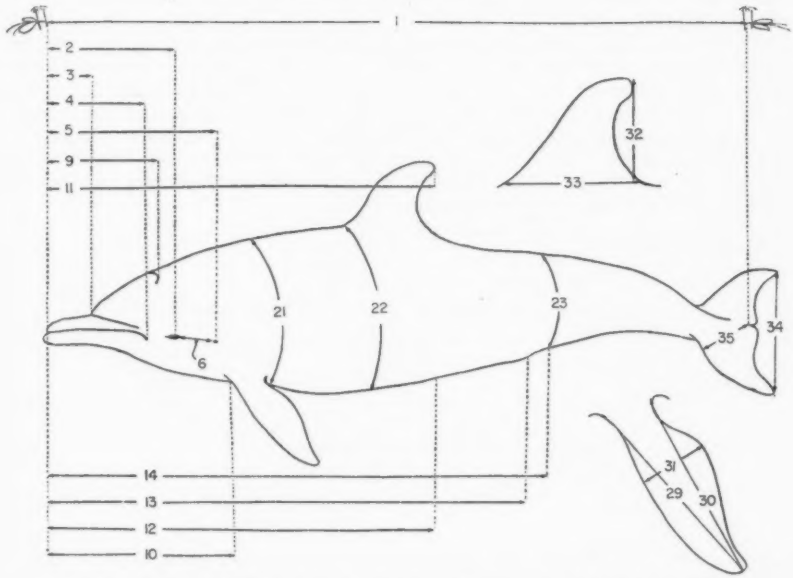

FIG. 1.—Diagram to illustrate external measurements recommended for smaller cetaceans.

otoliths, fish and squid lenses, squid pens and the like. The most significant information can be gathered by preserving in 10 per cent formalin the entire contents of the stomach and upper intestine. The stomach in cetaceans is sometimes divided into several distinct parts and each should be inspected. Usually undigested food will be found only in the first compartment.

PARASITES AND COMMENSALS

There are several important locations on the body of a stranded animal that should be inspected closely for parasites or commensals. Samples of these organisms should be preserved in 10 per cent formalin and carefully labeled. The external skin surface may harbor diatom films, barnacles and whale lice; nematodes may be found in the air sinuses of the head, the nasal passages, the stomach and the kidney; cestodes commonly infest the intestine; trematodes may be found in the intestine, liver and feces; and larval cestodes may be found buried in the blubber.

ACKNOWLEDGMENTS

Grateful acknowledgment is made for ideas borrowed from the *Guide for the identification and reporting of stranded whales, dolphins, porpoises and turtles on the British Coasts* (1953) by F. C. Fraser and H. W. Parker, British Museum (Natural History), 2d ed., viii + 42 p. The Committee is grateful to those senior cetologists, F. C. Fraser, Keeper of Zoology of the British Museum, Remington Kellogg, Director of the U. S. National Museum, and E. J. Slijper, Director of the Zoology Laboratory of the University of Amsterdam, for advice and suggestions. Dale W. Rice, John H. Prescott, Andrew Starrett and F. G. Wood, Jr., have also contributed valuable suggestions.

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THE SUBGENERIC STATUS AND DISTRIBUTION IN TIME OF *CITELLUS REXROADENSIS*

By Evan B. Hazard

Abstract: The type and paratypes of *Citellus rexroadensis* were collected at Locality 3, Rexroad fauna, Meade County, Kansas. This material, as well as material subsequently collected at this and three other localities, was examined and measured. On the basis of the form and relative size of the cheek teeth, *C. rexroadensis* is placed in the subgenus *Otospermophilus*. Isolated cheek teeth from the Fox Canyon Ranch average smaller than teeth from the type locality, although there is a broad overlap in individual measurements. This is interpreted as chronological variation over a short span of geological time. Specimens from the Buis Ranch, Beaver County, Oklahoma, of late Middle Pliocene age, indicate that *C. rexroadensis* had a relatively long geological distribution.

Citellus rexroadensis was described from material from Locality 3, Rexroad fauna, of the Upper Pliocene of Meade County, Kansas (Hibbard, 1941). The holotype and two paratypes are all rami. This paper reports additional material, including both upper and lower dentitions, from various Upper and Middle Pliocene localities.

I am indebted to Claude W. Hibbard for use of specimens from the collection of the University of Michigan Museum of Paleontology, and for patient advice on the preparation of this paper; to Emmet T. Hooper and William H. Burt for advice and for the use of specimens and facilities of the University of Michigan Museum of Zoology; and to Edwin C. Galbreath for the use of specimens and facilities of the University of Kansas Museum of Vertebrate Paleontology. This

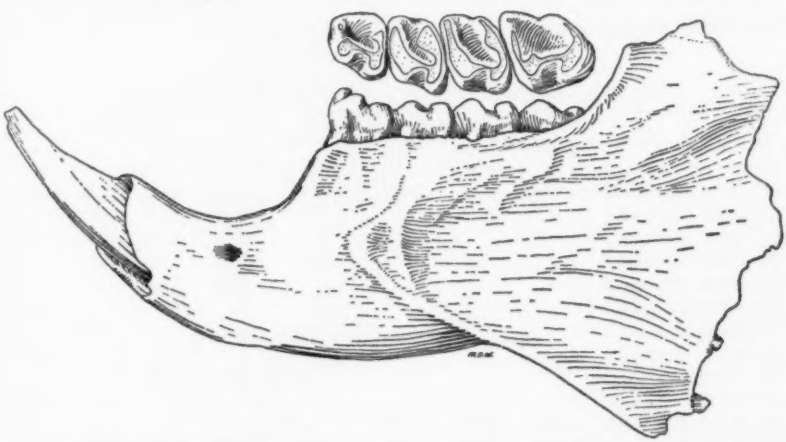


Fig. 1.—UM 41139, *Citellus rexroadensis* Hibbard, left ramus, Rexroad fauna, Kansas. Lateral and occlusal views. Length of cheek toothrow (P_4–M_3) 11.36 mm. Drawn by Michael O. Woodburne.

study was supported in part by a National Science Foundation Predoctoral Fellowship. Figures 1 and 2 were made by Michael O. Woodburne under National Science Foundation Grant 5635.

Measurements of material collected before 1959 were made with a single pair dial calipers. Specimens collected in 1959 were measured with a Gaertner traveling microscope. Most previously described material was remeasured to eliminate discrepancies caused by individual variation in technique. The transverse diameter of all but the oldest teeth seems to be little affected by tooth wear. Anteroposterior diameters, on the other hand, are often greatly affected by wear.

The fossils used in this study come from four deposits: Locality 3, Rexroad fauna, Meade County, Kansas (SW ¼ Sec. 22, T. 33 S, R. 29 W); Wendell Fox Locality, Meade County, Kansas (SW 40, SW ¼ Sec. 33, T. 33 S, R. 29 W); Fox Canyon, XI Ranch, Meade County, Kansas(SW ¼ Sec. 35, T. 34 S, R. 30 W); and the Buis Ranch, Beaver County, Oklahoma (NE 40, SW ¼ Sec. 5, T. 5 N, R. 26 E C.M.). The first three are late Upper Pliocene deposits. The fourth, originally believed to be early Upper Pliocene, is late Middle Pliocene (Tihen, 1955).

Abbreviations are as follows: KU—University of Kansas Museum of Vertebrate Paleontology; UM—University of Michigan Museum of Paleontology.

REXROAD 3 LOCALITY

Measurements of rami and maxillae from Locality 3 are given in Tables 1 and 2. The holotype and paratypes are, respectively, KU 4608, KU 4587, and KU 4732. UM 41139 is a left ramus showing slightly less wear than the holotype. The forward part of the jaw of UM 41139 is almost perfectly preserved, and the rear of the jaw is largely intact (Fig. 1). Among the several maxillae studied, UM 35052 and UM 41141 have complete cheek dentitions (Table 2). Both are the maxillae of young adults. UM 41141 is illustrated in Fig. 2. UM 37815 was the

TABLE 1.—*Measurements (in mm) of rami of* Citellus rexroadensis

Specimen	Locality	Length of toothrow			Diastema	Width of teeth			
		P_4–M_3	P_4–M_2	M_1–M_3		P_4	M_1	M_2	M_3
KU 4608	Rexroad 3	10.96	8.11	8.91	6.7*	2.63	3.05	3.31	3.08
KU 4587	Rexroad 3		8.41			2.68	3.00	3.28	
KU 4588	Rexroad 3			9.10			3.10	3.21	3.26
KU 4732	Rexroad 3		7.92		7.5*	2.71	2.90	3.17	
UM 29666	Rexroad 3					2.70	2.94		
UM 35048	Rexroad 3								3.55
UM 35049	Rexroad 3							3.50	
UM 35050	Rexroad 3								3.30
UM 35051	Rexroad 3					2.95	3.23		
UM 31056	Rexroad 3								3.79
UM 41139	Rexroad 3	11.36	7.95	8.89	7.72				
UM 41140	Rexroad 3	12.00	8.86	9.70	7.77	2.78	3.36	3.57	
UM 34738	Buis Ranch	11.00				2.75	3.05	3.08	3.00

* Measured by C. W. Hibbard.

TABLE 2.—*Measurements (in mm) of maxillae of* Citellus rexroadensis

Specimen	Locality	Length of toothrow		Width of teeth				
		P^3–M^3	P^4–M^3	P^3	P^4	M^1	M^2	M^3
KU 4772	Rexroad 3					3.55		
KU 5921[1]	Rexroad 3						3.73	
KU 5921[2]	Rexroad 3					3.36	3.90	
KU 5921[3]	Rexroad 3							3.41
UM 35052	Rexroad 3	10.87		1.43	3.08	3.41	3.46	3.20
UM 41141	Rexroad 3	12.12	11.33	1.79	3.19	3.74	3.79	3.64
UM 37815	Rexroad 3			1.68				
UM 29667	Rexroad 3				3.06	3.47	3.56	
UM 35054	Rexroad 3				3.27	3.89	3.83	
UM 34453	Wendell Fox						3.87	3.70
UM 34739	Buis Ranch		10.79		3.00	3.59	3.60	3.42

only isolated P^3 found (Table 2). Other cheek teeth, some in fragments of bone and others isolated, are included in UM 41142, UM 41143, UM 41144, and UM 42279. Measurements of these teeth were used in making Fig. 3 through 9.

The presence of complete upper cheek dentitions permits consideration of subgeneric relations (Howell, 1938). The pattern of the cheek teeth of UM

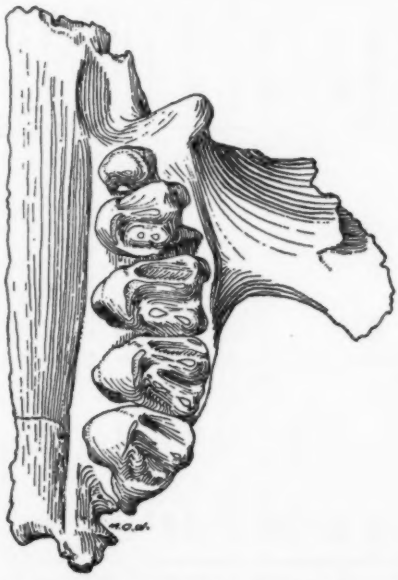


FIG. 2.—UM 41141, *Citellus rexroadensis* Hibbard, part of left maxilla, Rexroad fauna, Kansas. Occlusal view. Length of toothrow (P^3–M^3) 12.12 mm. Drawn by Michael O. Woodburne.

35052 and UM 41141 is similar to those of the subgenera *Otospermophilus* and *Callospermophilus*. The teeth P^4–M^3 seem to resemble *Otospermophilus* more closely but, disregarding size differences, there is a broad overlap in the ranges of variation found in extant species of these subgenera. I do not believe *Otospermophilus* and *Callospermophilus* are distinguishable with certainty on the basis of the form of P^4–M^3 alone. P^3 is of somewhat greater use than the other teeth. In *Callospermophilus*, a cingulum is often developed on the posterior lingual surface of P^3. The crown generally terminates in a single cusp, which sometimes forms a short obliquely transverse ridge. There is seldom any devel-

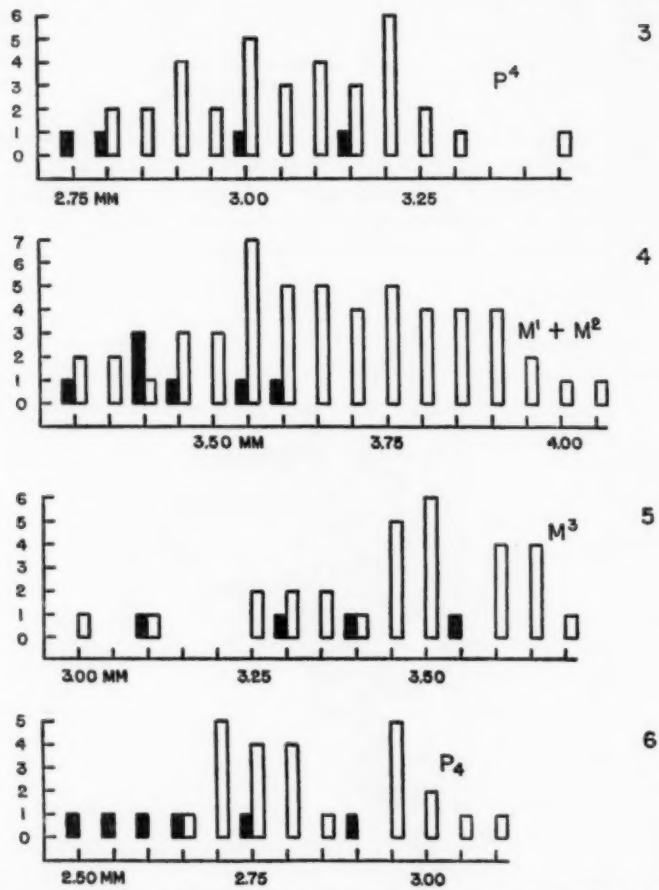
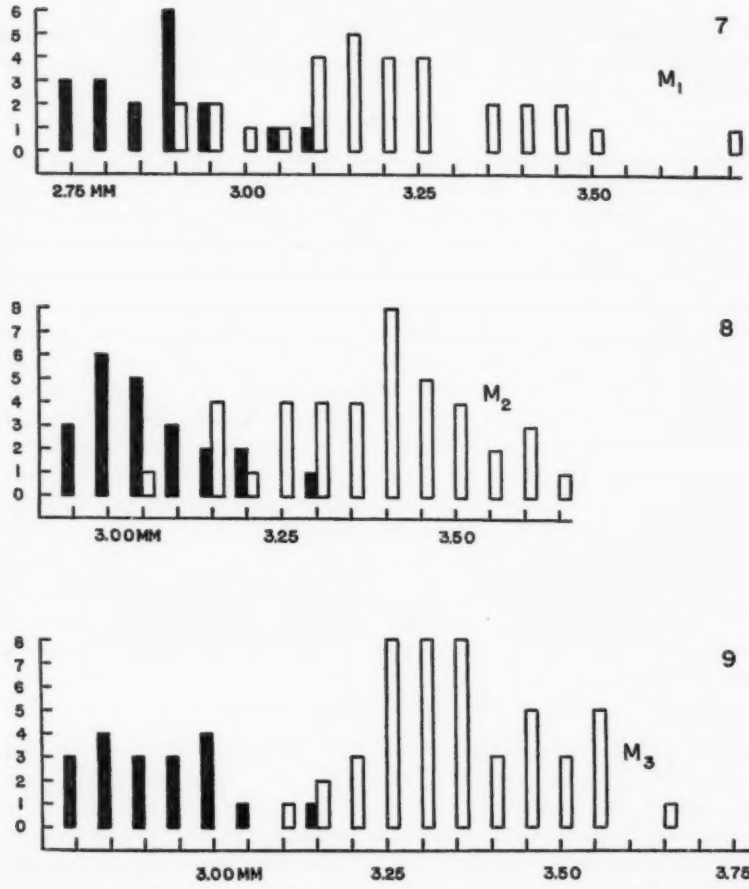


FIG. 3–9.—Widths of adult cheek teeth of *Citellus rexroadensis* from Rexroad 3 locality (white bars) and Fox Canyon locality (black bars). Each size class includes 0.05 mm. Thus,

opment of a two-cusped configuration or of an anterior cingulum. In *Otospermophilus*, the posterior lingual cingulum, when present, is less shelf-like and may terminate lingually in a stylid. The crown usually terminates in a short obliquely transverse ridge connecting two small cusps. A narrow cingulum is often developed on the anterior labial surface. In older adults of both subgenera, wear results in a rounded cone-like P^3.

In *C. rexroadensis*, the area of P^3 relative to the other cheek teeth is similar to that of *Otospermophilus* and *Callospermophilus*. In both UM 35052 and UM 37815 there is a simple posterior lingual cingulum, without a lingual stylid. In



in Fig. 3, five P^4 from Rexroad 3 and one P^4 from Fox Canyon measured between 2.96 and 3.00 mm.

UM 41141, there is also a well-developed posterior lingual cingulum, with a slight tendency toward the development of a stylid. In all three, the crown terminates in a ridge connecting two small cusps, as in *Otospermophilus*. In UM 41141 and UM 37815 there is a small anterior labial cingulum, but in UM 35052 there is none. None of the three specimens appears to have lost any of the characteristic structures on P^3 through wear. On the basis of the character of the upper cheek teeth and especially of P^3, it seems reasonable to place *Citellus rexroadensis* in the subgenus *Otospermophilus*. It is possible the *C. rexroadensis* is close to the common ancestry of *Otospermophilus* and *Callospermophilus*.

WENDELL FOX LOCALITY

A partial right maxilla, UM 34453 (Table 2), is that of a slightly larger than average *Citellus rexroadensis*. UM 34454 consists of a well-worn M^3 and a well-worn M_2 of this species.

FOX CANYON RANCH

Material from this locality includes many specimens of *Citellus howelli* Hibbard (Hibbard, 1941) as well as of a larger *Citellus*. The larger specimens include: UM 35056—one isolated broken M_2; UM 35059— milk P^4 and worn M_2, both in bone fragments; UM 35058—isolated cheek teeth including five milk P^4, one milk P_4, and 142 measurable adult cheek teeth. In form, these adult teeth are indistinguishable from those of *C. rexroadensis* from the type locality. Their average size is somewhat smaller, but there is a large overlap in measurements (Fig. 3–9). No. P^3 were found in the Fox Canyon material. In Fig. 4, the data for M^1 and M^2 are combined because these teeth, when isolated, cannot always be distinguished. All the cheek teeth, excepting perhaps M^3, tend to be smaller in the Fox Canyon specimens, the difference being greater in the lower teeth than in the upper teeth. The number of teeth from the Fox Canyon locality is at present too small to allow more detailed analysis. It seems unlikely that two contemporary populations of the same species, living about 10 miles from each other, would show the differences suggested by the available specimens. It is perhaps more likely that a relatively short time interval separates the two deposits, and that the observed differences represent a change in average measurements through time. The evidence does not seem to warrant taxonomic differentiation of the two forms.

BUIS RANCH

Material collected in 1952 from this late Middle Pliocene deposit was described (Hibbard, 1954) as a new species, *Citellus dotti*, which is a smaller species than *C. rexroadensis* but distinctly larger than *C. howelli*. In 1957, Hibbard's party collected a nearly complete left ramus with incisor and P_4–M_3 (UM 34738) and part of a right maxilla containing P^4–M^3 (UM 34739). These are indistinguishable both in form and measurements from *C. rexroadensis* from the Rexroad 3 and Wendell Fox localities. (No intact rami or maxillae have been collected from

the Fox Canyon Ranch.) The measurements of the Buis Ranch specimens are given in Tables 1 and 2. This material indicates that the species *C. rexroadensis* persisted as a relatively stable entity for at least the major part of the latter half of the Pliocene epoch.

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Dept of Biology, Bemidji State College, Bemidji, Minnesota. Received 13 March 1961.

SEASONAL REPRODUCTION IN THE MEADOW VOLE

By James R. Beer and Charles F. MacLeod

ABSTRACT: Population structure and reproductive condition of the meadow vole, *Microtus pennsylvanicus*, were analyzed for the period of July 1954 through July 1955. During this period there was a heavy snow cover throughout the winter and breeding was recorded for every month of the year. In the winters of 1954–55 and 1960–61, when there was very little snow cover, breeding ceased by 17 November and did not resume until about 20 March. From the 1954–55 period, 1,084; in the 1957–58 period, 37; and in the 1960–61 period, 217 meadow voles were examined.

Meadow voles, *Microtus pennsylvanicus*, were kill-trapped at bimonthly intervals between July 1954 and July 1955, to obtain a better understanding of the population dynamics of this species. Animals also were examined during the winters of 1957–58 and 1960–61. The area selected for study was on the University of Minnesota's Rosemount Experiment Station in Dakota County, Minnesota. The soils of the area are composed of about 24 inches of light sandy loam underlain by gravel. They were well drained, and there was no standing water with the exception of a period during the spring thaw when the soil was still frozen. The climate is typically continental with much of the precipitation coming in the summer months. During the 1954–55 period, there were no meteorological phenomena that diverged appreciably from normal. There was a continuous snow cover from the first week in December to the last week in March. However, the winters of 1957–58 and 1960–61 were notably free of snow cover. The snow cover did not appear to affect the activities of the meadow voles appreciably, but it did affect their availability.

During the snow-free period, the traps were set 3 to a station with 67 stations set in a line at 1-rod intervals. The lines were left out for 3 days. No attempt

was made to place the traps in those places most apt to catch mice. During the period when the ground was covered with snow the traps were placed singly in the tunnels where they approached the surface of the snow. The method used during the snow-free periods was designed to give an index to population density. The trap-success figures for the period when the ground was covered with snow could not be used to estimate population density. The trapping was carried out over a large enough area so that it would not appreciably affect the population.

The majority of the meadow voles were taken from fields planted to red clover, alfalfa and oats, or from fence rows and grassy waste areas adjacent to these fields. The samples varied from 56 to 132 voles per month during the 1954–55 period with a total of 1,084 specimens taken. In the winters of 1957–58 and 1960–61, samples of 37 and 217 meadow voles were taken and examined for reproductive condition.

At the period of the first collection in July 1954, the meadow vole population was at a moderate level as indicated by an index of 25 captures per 1,000 trap-station-days. The population density index increased to about 45 captures per 1,000 station-days by the end of October. This was followed by a sharp rise in apparent density as indicated by a success ratio of 86 captures per 1,000 trap-station-days. Snow fell during the last week in November, and by the first week in December the ground was covered for the winter. Between the first of December and the first of April, the trapping success ratios were meaningless, but our general observations indicated that the meadow vole density remained high and possibly increased slightly. During the last few days in March, the snow melted rapidly and the meadow voles were seen in considerable numbers wherever there was a little dry ground. The drop in population at this time, as indicated by a trapping success ratio of 6 captures per 1,000 trap-station-days, suggests that a large portion of the population was killed by exposure, predators and accidents. By the second half of April, the remaining meadow voles were concentrated in fence rows and the trapping success ratios here were high although the general population level was low. The general density climbed steadily from 6 captures per 1,000 trap-station-days in early April to about 31 captures per 1,000 trap-station-days in late July. This was only slightly higher than when the study started the previous July. In the winter of 1957–58 the population was quite low while in 1960–61 the population was quite high but probably not as high as during the 1954–55 season.

AGE STRUCTURE

The age structure of the population has a definite effect on the reproductive rate of meadow mouse populations, since the size of the litters varies with the size (age) of the females (Beer, MacLeod and Frenzel, 1957) and the observed sex ratio also varies with age (Beer, Frenzel and MacLeod, 1958). Assuming that the growth rate of the individuals in this population is similar to that reported by Hamilton (1941), there is a very small proportion of the population that exceeds an estimated 60 days of age.

The average body length of both the males and females for the entire 1954–55 sample was about 103 mm. There was considerable seasonal variation in the average body length (and presumably average age) of the population (see Table 1). There was also considerable difference in the proportion of adult animals. We here consider any animal with a body length of over 110 mm to be an adult. With these shifts in average age and per cent of adult animals, shifts in sex ratio are also apparent.

At the beginning of the study in July the males averaged 107 mm with 47 per cent over 110 mm in body length. The females averaged only 102 mm with 33 per cent of them over 110 mm in body length. In August the males and females averaged 106 and 105 mm in body length and 37 and 35 per cent were classed as adults, respectively. From this time the average size and the per cent of adult animals decreased until, in the winter, the average body length for the males and females was about 102 and 101 mm, respectively. The proportion of adults also declined to about 20 per cent in the winter.

In April the average body length rose abruptly to 111 and 108 mm for the males and females, respectively. More significant is the fact that at this time 71 and 43 per cent of the males and females, respectively, were of adult size. This change was due to differential survival of the size classes during the spring thaw and not to an increase in growth rate. The average body length of the males dropped sharply in May and June while the average size of the females held quite high. It is evident that the mortality rate of the adult males was much higher than for the females as the over-all sex ratio dropped from 56 to about 45 per cent males.

TABLE 1.—*Reproductive condition of* Microtus pennsylvanicus *by months, 1954–55*

Month	Females						Males				
	No.	Average body length	% over 110 mm in body length	% pregnant	% fecund	% with vagina open	No.	Average body length	% over 110 mm in body length	% with scrotal testes	% with tubular epididymus
July	40	102	33	43	55	70	47	107	47	78	70
Aug.	40	105	35	55	58	58	50	106	37	68	52
Sept.	45	100	25	38	51	62	67	102	28	39	54
Oct.	40	102	32	40	53	55	57	101	25	30	31
Nov.	51	100	21	20	35	41	82	96	4	9	4
Dec.	36	106	32	47	67	78	39	106	20	61	23
Jan.	24	101	8	29	46	58	32	103	19	38	32
Feb.	35	101	33	20	34	37	44	102	18	41	16
March	44	101	14	2	16	39	54	102	20	26	18
April	30	108	43	73	90	97	38	111	71	79	82
May	32	108	62	69	81	75	26	101	38	85	54
June	60	106	46	62	72	80	69	103	34	85	41

PREGNANCY AND FECUNDITY RATES OF FEMALES

Pregnancy rates are based on the proportion of the females examined that were visibly pregnant when the uteri were examined. Fecundity rates are based on the addition of females with placental scars and ruptured follicles to those that are visibly pregnant. The pregnancy rates are obviously low since very early pregnancies are not discernible, but the fecundity rates are fairly accurate. It was decided to use the data from all females trapped in 1954–55 samples in the calculations, since it is well known that the females may become reproductively active at a very early age.

None of the 68 female meadow voles with body lengths of less than 90 mm was found to be pregnant. Using the growth curve of Hamilton (1937) this means that none of the females under about 24 days of age was visibly pregnant. About 14 per cent of the females in the 90–94-mm size class were pregnant and the rate of pregnancy increased steadily with increasing body size (age) until about 67 per cent were found to be pregnant in the 110–114-mm body-length class (see Table 2). For all females with body lengths of over 110 mm, 67 per cent were visibly pregnant. If one added the number of females that were pregnant, but were not far enough along for implantation cites to be visible, the total per cent pregnant would be somewhat higher. However, using the minimum figure of 67

TABLE 2.—*Reproductive condition of the several size classes of* Microtus pennsylvanicus, *1954–55*

Body length	Females				Males		
	No.	% pregnant	% fecund	% with vagina open	No.	% with scrotal testes	% with tubular epididymus
55– 59	1	0	0	0	0	—	—
60– 64	2	0	0	0	1	0	0
65– 69	2	0	0	0	1	100	0
70– 74	5	0	0	0	8	12	0
75– 79	4	0	0	0	18	28	0
80– 84	21	0	0	29	22	18	0
85– 89	33	0	0	39	35	26	0
90– 94	42	14	14	45	48	21	6
95– 99	68	21	24	60	100	26	5
100–104	69	39	48	68	93	40	21
105–109	71	58	77	59	110	65	45
110–114	48	67	96	83	70	69	81
115–119	43	65	95	81	48	81	94
120–124	36	64	100	72	25	100	100
125–129	16	75	100	81	20	80	100
130–134	3	100	100	67	4	100	100
	464	40.2	54.4	61.6	603	48.9	37.9

per cent pregnant at all times and a gestation period of 23 days (Asdell, 1946), each female over 110 mm produced litters at the rate of 10.7 per year. This is an extremely high rate of reproduction even though not as high as the 17 litters in one year reported for a captive female by Bailey (1924).

Embryo counts varied from 1 to 11 with an average of 5.7. The calculated average litter size at birth was 5.2. The number of live embryos varied from an average of 4.3 for those females between 90 and 99 mm body length to 7.2 for those over 130 mm body length (Beer *et al.*, 1957).

Fecund females were first found in the 90–94-mm size class with a rate of 14 per cent. All of these were pregnant. The first animals with placental scars were found in the 95–99-mm size class. The fecundity rate increased more rapidly than the pregnancy rate until all animals over 120 mm in body length were found to be fecund (see Table 2).

The first indication of sexual maturity comes with the opening of the vagina. The first such signs were observed in the 80–84-mm size class where 29 per cent of the vaginas were found to be open. The proportion of females with open vaginas increased with body length until 83 per cent were found open in the 110–114-mm size class. Eighty-one per cent of the females over 110 mm long had open vaginas.

In examining the data from 174 pregnant females, where data were available on the closure of the vagina and embryo size, it was found that 15.5 per cent of the animals had closed vaginas. In those females which were judged to be pregnant on the basis of ruptured follicles or the presence of a capulatory plug, it was found that all of the vaginas were open. For those animals with embryos from 2–10 mm in length, 25 per cent had closed vaginas. Only two of the females or 3 per cent of the 67 with embryos over 10 mm had closed vaginas.

In examining the data for seasonal trends in reproductive rates, it was found that pregnancies occurred during every month of the year. However, there was some seasonal variation. From April through December, there was a high rate of pregnancies with the exception of November, when there was an exceptionally high proportion of small animals in the sample. For this period, 48.1 per cent of the females examined were pregnant. During the period of January through March, only 12.2 per cent of the females were pregnant. In March, only 1 of the 44 females examined was pregnant.

The fecundity rates also varied in a similar fashion with 61 per cent fecund during the April through December period and 24 per cent fecund during the January through March period. The proportions of females with open vaginas varied less, with 64 and 36 per cent of the females with open vaginas for these periods, respectively.

FECUNDITY RATES OF MALES

The pattern of development of sexual maturity in the male meadow vole in the 1954–55 sample is similar to, but somewhat slower than that found in the females (see Table 2). The development of the scrotum and the descent of the testes into it is the first indication of sexual development in the males. This comes at a very

early age, with some animals in the 65–69-mm size class showing this development. The presence or absence of the testes in the scrotum is not a good indicator of fecundity, since the testes become scrotal in position before sperm production starts and because animals that are not killed quickly by the traps may draw the testes up into the abdominal cavity.

A few animals as small as 90–94 mm in body length were found to have tubular epididymi, but it was not until body lengths of over 100 mm were obtained that an appreciable proportion had this development (see Table 1). The proportion that was fecund increased steadily until all animals over 120 mm in body length were found to be so.

As in the females, there was a seasonal difference in the proportion of the males that were fecund. For the period from April through December, 46 per cent of the males had tubular epididymi and were considered fecund, while for the period from January through March only 21 per cent of the males had tubular epididymi. The testes were in a scrotal position in 61 per cent of the males in the April through December period and in 34 per cent of those taken in the January through March period.

DISCUSSION

The data presented show that the meadow vole will breed throughout the year under conditions where food and cover are suitable. In this case it was a good snow cover which came before the first heavy freeze. Even under these conditions the rate of breeding was reduced during January, February and March. However, the differences are not as great as the gross figures indicate since at least part of the apparent difference is due to the larger proportion of young animals during the period of low reproductive rates. There was no indication of a midsummer lull in breeding as found by Lantz (1960).

During the winter of 1957–58, small samples of meadow voles were examined and none was found to be in reproductive condition. From the middle of November 1960 to the first of April 1961, meadow voles were live-trapped and none was found to be in reproductive condition. Both of these winters were without a protective snow cover except for brief periods.

The data also indicate a very high reproductive rate and an equally high mortality rate with relatively few of the animals reaching an age of more than two or three months.

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BREEDING SEASON OF THREE RODENTS ON WHITE MOUNTAIN, CALIFORNIA

BY WILLIAM W. DUNMIRE

ABSTRACT: Data on breeding condition and sex ratio are presented for *Reithrodontomys megalotis*, *Peromyscus crinitus* and *Lagurus curtatus* at four elevations from 4,500 to 12,400 feet in southern California. In all, 662 "potential adults" were snap-trapped at five periods throughout the year.

During a recent study of variation in reproduction of *Peromyscus maniculatus* at different altitudes on White Mountain, Mono County, California (Dunmire, 1960), reproductive data were acquired for *Reithrodontomys megalotis*, *Peromyscus crinitus* and *Lagurus curtatus* also living in the area. White Mountain provides an accessible range of elevation from a little over 4,000 feet at its base in Owens Valley to its summit 10,000 feet higher—all within a linear distance of less than 20 miles.

Methods.—Five collecting trips were made over a year from October 1956 through July 1957. Four trapping areas were established at 4,500, 7,100, 9,800 and 12,400 feet elevation. The two lowest sites were in Silver Canyon along or near a small stream where low shrubs such as *Atriplex*, *Chrysothamnus* and *Artemisia* compose the dominant plant cover. At 9,800 feet, trapping was done along the north fork of Crooked Creek, where sage (*A. tridentata*) makes up 90 per cent of the vegetation. The highest station was located near Mt. Barcroft (on the White Mountain massif south of the summit) in an alpine meadow and rocky setting above the zone of sage. These areas are described more fully in the *Peromyscus* paper.

Snap-trapped mice were weighed, measured, examined for pelage condition and autopsied. For males, size of testes, seminal vesicles and epididymides were recorded. Following Jameson's (1950) conclusions, whenever the tubules of the cauda epididymis were so swollen as to be clearly visible to the naked eye, males were considered to be in breeding condition. Occasional epididymal smears were made and examined, which confirmed that the visual method was applicable to all three species.

Females were considered to be in breeding condition if they were pregnant or lactating or if they exhibited an open vagina or fresh corpora lutea.

Only "potential adults" are included in the data below. Potential adults are considered to be those mice that weigh at least as much as the minimum weight in the samples for a breeding male or female of each species. Although it is recognized that this is an arbitrary classification that will surely include a few juveniles and exclude an occasional true adult, the method does tend to refine the data somewhat and it allows comparison of each population at different times of the year when age structures might differ considerably. Of course, most juvenile mice will be automatically eliminated from the data. Tables 1, 2 and 3 include the total number of adults captured at each elevation.

Reithrodontomys megalotis.—In early October 1956, the breeding season of harvest mice was clearly at its height at both elevations where nine of the ten adult females taken were actually pregnant, and the tenth was lactating. Nearly all males were in full breeding condition. By January, breeding had apparently stopped. None of the six females exhibited fresh uterine scars, indicating that reproduction had terminated at least a month beforehand.

It appears that both males and females came into breeding condition some time in early spring at both elevations. In March at 4,500 feet one female in nine was pregnant (but resorbing); another was judged to be undergoing a sterile estrous cycle. Furthermore, in March only 2 of 47 mice captured from both areas weighed less than 9.0 grams, the assumed minimum adult weight, and these two were practically that weight. Thus it seems that there had been no recent breeding. The May and July samples indicate that sporadic breeding took place throughout the spring and summer months.

TABLE 1.—Reithrodontomys megalotis: *breeding condition of potential adults.*

Date	Elevation	Males		Females	
		Breeding	Not breeding	Breeding	Not breeding
1956					
2–12 Oct.	4,500	9	2	6	0
	7,100	2	0	4	0
1957					
5–13 Jan.	4,500	0	2	0	2
	7,100	0	2	0	4
6–10 Mar.	4,500	6	21	2	7
	7,100	1	3	†	†
3– 5 May	4,500*	16	3	5	17
	7,100	5	0	1	0
20–23 July	4,500*	1	1	0	2
	7,100	3	0	5	0

* May include some subadults.

† Examined for pregnancy only (all 5 taken were non-pregnant).

The data suggest that at both areas *R. megalotis* has an extended breeding season from early spring until late fall with an increase in activity during the fall. Breeding does not seem to occur in midwinter.

Sex ratios for all *Reithrodontomys* (including juveniles) captured throughout the year are as follows: 4,500 feet—81 ♂ ♂ :56 ♀ ♀; 7,100 feet—29 ♂ ♂ :28 ♀ ♀.

Peromyscus crinitus.—At the lower site there was little or no breeding of canyon mice in October. Only one female was completing an estrous cycle, while none of the others even contained fresh uterine scars. No males were in reproductive condition. Higher on the mountain the breeding season was nearing its end. Several of the females were lactating but only two were pregnant, and less than half of the males remained in an active condition. By January there was no reproduction at either area.

Reproductive activity resumed in March, with most of the males in breeding condition at that time. Although some females had begun estrous cycles (at 4,500 feet, at least), no pregnant mice were captured at either elevation. Of the 79 mice trapped in March, all were adults (11.8 grams) or nearly so; therefore it can be assumed that reproduction had ceased during the winter.

In May at 4,500 feet most males contained apparently regressing gonads (the testes were mostly large, soft and reddish, but the epididymides were not visible to the eye), and only 15 per cent of the females were in breeding condition (none pregnant). At 7,100 feet moderate reproduction was taking place, but by late July breeding had stopped at both areas in Silver Canyon.

The samples imply that canyon mice on White Mountain may breed in the spring only at lower elevations, but at higher elevations there seems to be a split season with reproduction in spring and late summer or early fall and a midwinter and aestival dropoff. The latter situation is similar to that described for *Pero-*

TABLE 2.—Peromyscus crinitus: *breeding condition of potential adults*

Date	Elevation	Males		Females	
		Breeding	Not breeding	Breeding	Not breeding
1956					
2–12 Oct.	4,500	0	5	1	10
	7,100	8	13	7	9
1957					
5–13 Jan.	4,500	0	5	0	11
	7,100	0	17	0	16
6–10 Mar.	4,500	15	8	4	3
	7,100	12	8	*	*
3– 5 May	4,500	1	20	3	17
	7,100	9	34	11	36
20–23 July	4,500	0	4	0	2
	7,100	2	26	0	31

* Examined for pregnancy only (all 26 taken were non-pregnant).

myscus maniculatus at both 4,500 and 7,100 feet during the same period (Dunmire, 1960); however, for *P. maniculatus* there was some indication that sporadic breeding continued throughout the winter. Jameson (1953) found that *P. maniculatus* in the northern Sierra Nevada also have a split breeding season.

The sex ratios for all *P. crinitus* captured, including juveniles, were: 4,500 feet—68♂♂:75♀♀; 7,100 feet—143♂♂:148♀♀.

Lagurus curtatus.—The data are insufficient to furnish a clear picture of the breeding season for this species found at the two highest trapping sites on White Mountain. The mice captured at 12,400 feet probably represent an altitudinal record for sage voles. Pregnant females were taken in October, January, March and July, which suggests that breeding took place throughout most of the year. Males were in breeding condition during each of the five collecting trips except in October. It has been established previously that *L. curtatus* also may breed during an entire year in eastern Oregon (Moore, 1943) and eastern Washington (Johnson *et al.*, 1948).

It may seem surprising that all six mice captured in January were reproductively active in an area (9,800 feet) where daytime temperatures tend to remain below freezing, and the average minima are less than 15°F. However, since these mice are primarily foliage eaters, food would be available at this time of the year as well as any other. It is entirely possible that winter is the least difficult time for *Lagurus* populations here. Foliage that is normally inaccessible could be reached from the top of the snow pack, and the snow itself, which accumulates to depths of two or more feet on White Mountain, would provide ample protection from predation to mice traveling along their ground-surface runways. Thermometers placed in rodent burrows beneath the snow at White Mountain showed that the burrows rarely got much colder than freezing, even when corresponding air temperatures descended below 0°F.

TABLE 3.—Lagurus curtatus: *breeding condition of potential adults*

Date	Elevation	Males		Females	
		Breeding	Not breeding	Breeding	Not breeding
1956					
29 Sept.–	9,800—none captured				
8 Oct.	12,400	0	1	3	0
1957					
6– 9 Jan.	9,800	5	0	1	0
	12,400—no trapping				
11–14 Mar.	9,800	1	0	1	2
	12,400—none captured				
6–13 May	9,800—none captured				
	12,400	1	0	0	0
21–22 July	9,800	4	0	1	0
	12,400	2	0	0	1

Although *L. curtatus* are normally associated with a sage habitat, sage does not grow at my highest trapping area, 12,400 feet, on White Mountain. Presumably the foliage of such forbs as *Chrysothamnus*, *Trifolium*, *Phlox* and *Polemonium*, and grasses (*Sitanion* among others) are eaten here.

Severe population fluctuations are a known characteristic of this species, and the extended breeding periods cited for sage voles in Oregon and Washington (*op. cit.*) seem to have occurred during sudden population increases. In northern Alaska brown lemmings may multiply a hundredfold in a single winter during the upswing of the 3- to 4-year lemming cycle (Pitelka, 1957). Whether the year-round breeding that occurred in 1956–1957 is the normal situation for sage voles at White Mountain, or whether my sampling coincided with the buildup phase of a population cycle, is a question that remains unanswered.

Sex ratios for the entire sample are: 9,800 feet—14♂♂:8♀♀; 12,400 feet—7♂♂:5♀♀.

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EFFECT OF FLOODING ON A POPULATION OF MICE

By David G. Ruffer

Abstract: A study of the effect of spring flooding on the movements of a marked population of white-footed mice, *Peromyscus leucopus noveboracensis*, was conducted in Wood County, Ohio. The study area included 0.71 acre and was flooded on two separate occasions; once the leaf litter was so saturated as to be uninhabitable.

Live traps and nest boxes were used to obtain recapture data from which home ranges of the 19 resident mice were calculated by the boundary-strip method. Home ranges averaged 0.19 acre for resident males and 0.20 acre for females. Flooding did not cause enlargement of home ranges, but did lead to increased use of the peripheral portions of the established home range and above-ground nesting sites. Flooding did not seem to inhibit movements of the mice within the area nor was it detrimental to their numbers.

Flooding is disruptive to the activities of terrestrial animals by destroying, temporarily at least, the usefulness of their habitat. This study is concerned with the effects of spring flooding on the movements of white-footed mice, *Peromyscus leucopus noveboracensis*, living in forested bottomlands.

Among studies that have dealt with the effect of flooding on populations of small mammals are those by Blair (1939), Grinnell (1939), Yeager (1949), and Yeager and Anderson (1944). Stickel (1948) found that a flash flood in Maryland had little effect on size of a population of white-footed mice and that individuals showed a tendency to remain within their home ranges. McCarley's (1959) study of the effect of flooding on two populations of *Peromyscus gossypinus* and *P. nuttalli* in east Texas supported the results of Blair (1939) for flooding of a longer period and of Stickel (1948) for short-term flooding. Davis *et al.* (1951) indicated that induced flooding of a woodland habitat did not alter the population of white-footed mice during the initial years of observation.

These studies, except the last, were derived from stream or lake flooding, either temporary or permanent in nature, which may destroy rather than merely disrupt the habitat. The effects of annual, small-scale flooding which often occurs in scattered bottomland habitats seems not to have been studied. The present study involves the effect of this latter type of flooding on a marked population of white-footed mice.

The study area was in the Steidtmann Wildlife Refuge of Bowling Green State University, Wood County, Ohio. This general locale is a glacial lake bed often termed the Black Swamp (Kaatz, 1955). The area is in the beech-maple forest region and is characterized by a mixed oak association, including red oak (*Quercus rubra*), swamp white oak (*Q. bicolor*), and red maple (*Acer rubrum*) in the overstory. Herbaceous vegetation was sparse. The more depressed areas of the woods are filled by surface drainage to a maximum depth of about 2 feet each spring for several months, or less, depending on climatic conditions. The area included 0.71 acre of woodland bordered on the south by a winter wheat field and on the other sides by contiguous woodland, the north being a sandy, glacial lake ridge from 3 to 12 feet high.

METHODS

Movement patterns of resident mice (those captured 4 or more times during the study) were determined by live-trapping. Mice were marked by toe-clipping and were released at the site of capture. The live traps were constructed by bolting 1-quart oil cans to Museum Special traps and wiring ¼-inch hardware cloth to the trigger bar. Cotton was placed in the cans to reduce mortality from freezing; no deaths were recorded, even though night temperatures reached 3°F.

A trapping grid was established with 60 stations at approximately 30-foot intervals. Each trapping period covered three nights, and one-third of the grid was trapped at a time. The entire area was trapped three times before the first flooding period in February. From this unil the third period of high water, trapping was done both within the area and on a 60-foot, wooded perimeter strip.

After the water had receded, in June, the study was terminated with a 7-day period of intense kill-trapping to determine the total number of mice living in the area. Traps were set both in the study area and in perimeter strips.

A corrected trap-success ratio was used as an index to population abundance and was calculated with the following formula:

$$\text{Trap success} = \frac{\text{Number of captures}}{\text{Total number of traps} - 0.5 \text{ sprung traps}}$$

This method corrects for randomly sprung traps and assumes that these were sprung at an arithmetic rate during the trapping period. One-half the number of traps sprung thus approximates the number of traps not available to catch the essentially nocturnal mice during the trapping period (Jackson, 1952). Only during the last few weeks of the study was trap disturbance appreciable because of slugs (*Deroceras* sp. and *Philomycus* sp.) and land snails (*Mesodon* sp.).

Home range of an animal has been defined as that area around its established home which is traversed by the animal in its normal activities of food gathering, mating, and caring for young (Burt, 1940). Many techniques of estimating home range have been devised, but the boundary-strip method (Stickel, 1954) seemed most adaptable for the present data. A peripheral strip, equal in width to one-half the distance between traps, is laid around the minimum area revealed by capture points, and the total area enclosed is calculated. While this method was criticized by Hayne (1949), because it adds to an area of certain movement an area in which the mouse is not definitely known to travel, he pointed out that an arbitrary system of trap settings does not necessarily correspond to the actual home range either.

Nest boxes were installed to provide a more efficient method of observing mice and providing dry nesting sites during the spring flooding. The boxes were constructed of ½- inch plywood with roofs which could easily be lifted for examination (Jackson, 1953). Fifty such boxes with inside dimensions of $4 \times 4 \times 4.5$ inches were fastened to trees 4 feet above the ground, and an additional 23 boxes (inside dimensions of $4 \times 4 \times 9$ inches) were placed on the ground. The boxes had a 1-inch square entrance hole, and cotton was provided for nesting material. The boxes were checked at weekly or biweekly intervals.

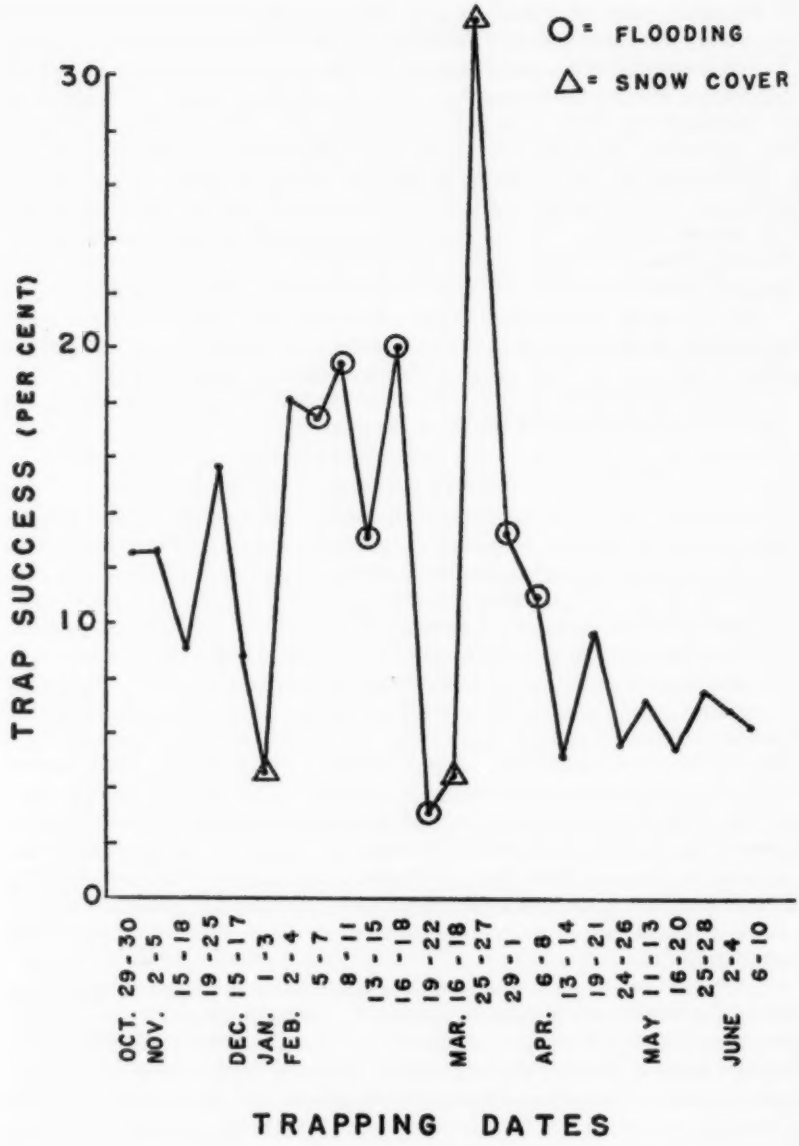

FIG. 1.—A comparison of trap success and trapping dates, 1959–1960.

RESULTS

Virtually the entire small mammal population consisted of white-footed mice. During the 7½ months, 62 white-footed mice and two short-tailed shrews, *Blarina brevicauda*, were captured in both live- and snap-traps. Of the 62 mice, 31 were males.

Trap success for a three-day period ranged from 3 per cent during the final days of the first flooding period (19–22 February) to 31 per cent prior to the second flooding period (25–27 March). Several factors influenced trap success. The number of available traps varied because of trap disturbance and differing numbers of traps initially set. By computing a corrected trap-success ratio, an attempt was made to correct for such variations. While snow might be expected to make traps less available, no attempt was made to place them in subnivean runways. Trap success was not consistently lowered by snow cover (Fig. 1).

No relationship was found between trap success and moon phase or cloud cover by Jackson (1952). No correlation with moon phase was found in this study. Ground level temperatures between 0630 and 0700 hours, prior to checking the traps, were not those at the time of maximum mouse activity, but were indicative of the night temperatures. Trap success for each trapping period compared to mean morning temperatures for that period (Fig. 2) indicated an apparent inverse relationship.

TABLE 1.—*Summary of home-range data of resident white-footed mice in relation to flooding*

Mouse number	Number of captures	Area in home range, acres	Time between first and last captures, days	Flooding period
Males:				
1300	5	0.19	145	1
2100*	4	0.10	15	none
5300	14	0.30	65	1
5400	10	0.25	144	1
0023	9	0.40	32	2
0044	5	0.07	43	1
0054	6	0.11	16	1
Females:				
1100	6	0.18	164	1, 2
2200	4	0.10	195	1, 2
3100	11	0.20	134	1
3500*	4	0.18	84	none
4100*	5	0.36	74	1
5500*	4	0.07	9	none
0025	7	0.26	45	2
0043	9	0.24	117	1, 2
0052	4	0.25	53	1
0053	5	0.05	53	1
1020	11	0.38	66	2
2030	5	0.12	42	none

* Individuals not captured after a flooding period.

Movements of mice.—Portions of the study area were flooded on two separate occasions; during another period, although not inundated, the area was considered uninhabitable at the fossorial level as a result of extremely saturated leaf litter. The first flood (5–21 February) resulted from the melting of a heavy snow. It covered the entire terrestrial portion of the home ranges of half the resident mice. The second flooding (28 March to 7 April) resulted from melting snow and rain, and covered the same area; the remainder of the area was too saturated for leaf litter habitation. During this period, the home ranges of 17 of the 19

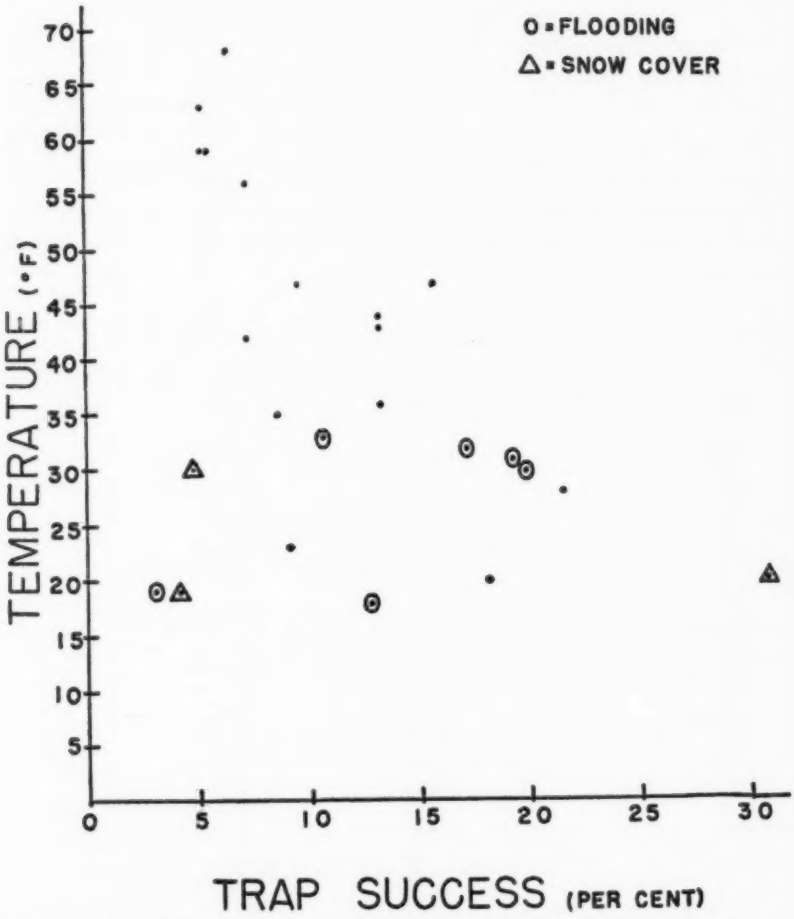

FIG. 2.—The relationship between morning ground level temperature and trap success.

resident mice were affected. Two mice had home ranges extending north of the study area, but their most frequent points of capture were on islands within the flooded area.

Heavy rains during April resulted in a month, from 24 April to 24 May, when the ground was too saturated to be habitable, though not inundated. Again, 90 per cent of the resident individuals had home ranges corresponding entirely to the area of uninhabitable leaf litter.

Movement patterns of the mice relating to flooding are summarized in Table 1. Resident mice captured during periods of flooding were captured at extremes of their home range (32 captures), at new sites (30 captures), or at sites of previous capture (15 captures). New sites of capture were within the pattern of an already established home range. Four individuals were not captured after a flooding period, and their death or dispersal beyond the study area was assumed. Since movement patterns in the three periods of flooding are essentially the same, the data have been combined.

The 19 resident individuals included 12 females. This differs significantly from the ratio of equality of total captures ($P = 0.02$). Home ranges for females average 0.20 acre (range: 0.05 to 0.38 acre) and for males 0.19 acre (range: 0.05 to 0.40 acre). However, mice captured 10 or more times had an average home range of 0.28 acre, supporting the criticism that an individual must be captured 15 or more times to approximate its true home range (Davis, 1953). These data differ from most in that male and female home ranges were essentially similar.

Maximum movement is the greatest distance between points of capture. Differences in maximum movement for the mice during preflooding and flooding conditions were not statistically significant ($P = 0.10$) because of a large amount of variation resulting in standard deviations equal to approximately one-third the average distance.

Nest boxes.—Nest boxes have been found a convenient means of studying small mammal populations (Nicholson, 1941). Jackson (1953) has described two types of nests constructed by *P. leucopus* in nest boxes attached to trees. The same nest types were observed in this study. One type, used for sleeping and raising young, was a hollow sphere of shredded cotton with an entrance near that of the box. In only one of 72 different nests of this type were additional materials used. This one was augmented with pieces of metal screen taken from a trash pile 27 feet distant.

A second type of nest was in the form of a cotton platform used as a feeding station. Food was not stored here, but there was ample evidence of feeding activity in the form of empty pupal cases and acorn shells. Platform nests were constructed in unused boxes or from spherical nests; at times, spherical nests were formed from feeding platforms.

Six defecation stations were also observed. These concentrations of feces and urine were found in the uninhabited boxes and in four boxes with feeding stations. In sleeping nests, urine concentrations were generally observed in one corner, but fecal accumulations were lacking.

Data obtained from nest boxes are summarized in Table 2. A box was considered unused if no new activity was recorded in it since the last observation. The data indicated a gradual increase in use of the boxes during the study period; a relatively greater utilization of spherical nests during 1960, following flooding, was observed.

Little information was obtained from the larger boxes placed on the ground. Occasional pellets were found, and once a mouse was captured in a box containing a spherical nest. These were the only indications of use.

The only vertebrates other than white-footed mice observed in the boxes were a pair of southern flying squirrels, *Glaucomys volans*, who raised three young in one box. The female did not enlarge the entrance, as observed by Jackson (1953), even though she entered with considerable difficulty.

Various invertebrates were associated with the nest boxes after 13 April. Ants, spiders, wasps which built nests on the underside of nest box lids, wood roaches and carabid beetles were very common. Fleas were often found in cotton nesting material in nest boxes. The mice fed on the wasps, apparently when immobilized by cool temperatures.

Nesting activity.—When the area was not flooded, the mice, upon release, went either to nest boxes or to nests in the leaf litter. After flooding, the leaf litter in most of the area was uninhabitable, and different patterns of activity occurred. Nests were noted in small areas of land not flooded, and nest boxes were used with greater frequency; but nests occurred more often in other places. One white-footed mouse lived in a 2-gallon oil can lying in an area of partial inunda-

TABLE 2.—*Summary of tree nest box usage by white-footed mice*

Observation dates, 1959–1960	Habitable boxes	Spherical nests	Feeding nests	Defecation stations	Unused sites	Captures	
						A†	B‡
26 Oct.	50	0	0	0	50	0	0
14 Nov.	50	10	4	0	36	4	0
22 Nov.	48	10	3	0	35	3	0
14 Dec.	48	12	15	2	19	3	0
31 Dec.	48	15	17	0	16	4	0
17 Jan.	48	19	15	0	14	6	0
1 Feb.	48	20	15	0	13	9	0
12 Feb.*	48	23	13	0	12	4	0
20 Feb.*	48	25	7	0	16	3	0
11 Mar.	48	24	9	2	13	2	0
20 Mar.	48	23	7	2	16	2	0
27 Mar.*	48	21	8	2	17	0	0
3 Apr.*	48	23	12	2	11	3	0
13 Apr.	48	26	11	0	11	5	3
23 Apr.	48	25	14	1	8	6	8
1 May*	48	23	15	1	9	5	8
15 May*	48	24	17	0	7	4	11

* Indicate observations taken during flooding periods.
† Adult captures. ‡ Immature captures.

tion. Other nests were observed between peeling bark and tree trunks (*Quercus bicolor*), and a small hollow log served as a nesting site for one mouse. Several trees in the area had died and broken, leaving tall stumps; two nests were noted on these. Observations of this type of nesting behavior were not noted during nonflooding periods.

Winter activity.—During periods of heavy snow cover, tracks of mice were observed. At seven places paths averaging 30 feet in length were established between holes under the snow and nest boxes. In five cases, the paths went from holes to boxes with spherical nests; once to a defecation station; and once from a sleeping nest to a feeding platform. In all cases the paths were well worn and indicated considerable use. Although there was extensive movement within the study area and on top of the ridge to the north, no trace of movement up or down the ridge was noticed.

DISCUSSION

This study was designed to measure the effect of small-scale spring flooding on a known population of white-footed mice living in a bottomland wood. The entire terrestrial portion of the home ranges of 17 resident mice, and more than 75 per cent of the terrestrial portion of the home ranges of two other residents, were made uninhabitable during three periods of high water.

During flooding periods, the average number of nest boxes with spherical nests (24) increased by 50 per cent over the preflooding number, while the number of feeding platforms remained essentially unchanged (Table 2). These data suggest that mice, at times of high water, move from ground-nesting sites. The lack of significant increase in numbers of mice actually captured in nest boxes (5 to 6) after flooding suggests that the mice may spend less time in these nests. The unaltered status of feeding-platform use indicates no observable flood effect on this aspect of feeding.

After release, mice were frequently observed moving about on wet ground, swimming short distances, and moving on fallen logs across flooded areas. Thus, bottomland flooding appeared not to have greatly inhibited their movements. Differences between maximum distances moved in flooding and preflooding periods were statistically insignificant, but the trapping data indicated a significant increase ($P = 0.01$) in utilization of the peripheral portions of the home range, even though partially flooded. This may result from the forced use of more distant food supplies because of the inaccessibility of previously used areas.

The population was estimated by the recapture-ratio method (Davis, 1959). In November, the population was estimated between 11.6 and 24.4 individuals (mean ± one standard error); in May, 18 marked mice were killed in the terminal trapping. Thus, the estimate of resident mice within the area is in good agreement with the trap-out results. During the study, the population appeared to remain stationary, since each individual killed accidentally in trapping was replaced by an unmarked mouse.

In this study, moon phase or periods of flooding or snow cover had no consistent effect on trap success, but an inverse relationship between temperature and

trap success was indicated (Fig. 2). Perhaps the higher metabolic demands of winter required wider ranging for food, and thus greater trap exposure. The flooding seemed to force the mice into utilizing more above-ground nest sites and peripheral portions of their home range, but did not appear detrimental.

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A NEW COYOTE IN THE LATE PLEISTOCENE OF TEXAS

By Bob H. Slaughter

Abstract: A lower jaw, collected from a deposit in Denton County, Texas, and currently believed to be of Sangamon age, is compared with living and fossil forms and described as a new subspecies of *Canis latrans*.

Late in 1955, R. K. Harris and W. W. Crook, Jr., collected a left lower jaw of a coyote-sized canid from the basal Upper Shuler member of the Pemberton Hill-Lewisville terrace of the Trinity River (Elm Fork) in southern Denton County, Texas. The locality was described as the *Lewisville Site* by Crook and Harris (1957) and the specimen was entered in that report as *Canis* sp. In a later report (Slaughter *et al.*, 1961) the same specimen was included as *Canis* sp., with the suggestion that it might be related to *C. caneloensis*. Both have certain wolf-like characters. The holotype of *C. caneloensis* is a skull and a fragment of a lower jaw found in association has the crowns missing from the teeth. However, after examining a cast of this jaw fragment and noting the indicated small anteroposterior diameter of p_2 plus the distance between p_1 and p_2, the possibility that the Denton County specimen belonged to that species was abandoned. Subsequent study of other fossil and Recent material indicates that the Denton County specimen represents a new form that could be ancestral to one or more of the living coyotes. All Late Pleistocene coyote jaws from Texas with which the new canid could be compared were found to be referable to the same subspecies.

My sincere appreciation is expressed to Walter Dalquest, Midwestern University, who, considering the supposition that the type locality deposit is interglacial, suggested that it be compared with Recent material from the southern extremity of the present range of *C. latrans*. I am indebted to E. R. Hall, University of

Table 1.—*Comparison of measurements (in mm) of new fossil and several living forms of coyote*

Feature	*C. l. harriscrooki* n. ssp.	*C. latrans*, living forms Min.	Avg.	Max.
Anteroposterior diameter of p_1	4.5	4.2	4.4	5.0
Transverse diameter of p_1	3.5	2.4	3.4	3.7
Anteroposterior diameter of p_2	10.8	8.7	10.1	11.5
Transverse diameter of p_2	5.0	4.0	4.5	4.8
Anteroposterior diameter of p_3	12.2	9.3	11.3	13.0
Transverse diameter of p_3	6.3	4.0	4.9	6.5
Anteroposterior diameter of p_4	13.9	10.0	11.7	13.3
Transverse diameter of p_4	6.3	4.7	—	6.5
Anteroposterior diameter of m_1	24.2	18.7	20.7	23.0
Transverse diameter of m_1	8.0	7.0	7.2	8.7
Anteroposterior diameter of m_2	10.0	9.8	10.2	11.1
Transverse diameter of m_2	7.3	6.8	7.2	7.4
Depth of mandible at anterior edge of m_1	19.2	16.0	19.2	22.0
Length of cheek tooth series, p_1–m_3	82.0	71.0	79.7	85.9

Kansas, G. G. Goodwin, American Museum of Natural History, G. H. Lowery, Louisiana State University, and Ernest Lundelius, University of Texas, for the loan of specimens from Honduras, Mexico, and the United States; to M. F. Skinner, Frick Laboratory, American Museum of Natural History, for furnishing a cast of a jaw fragment associated with the type of *C. caneloensis*; and to Martin

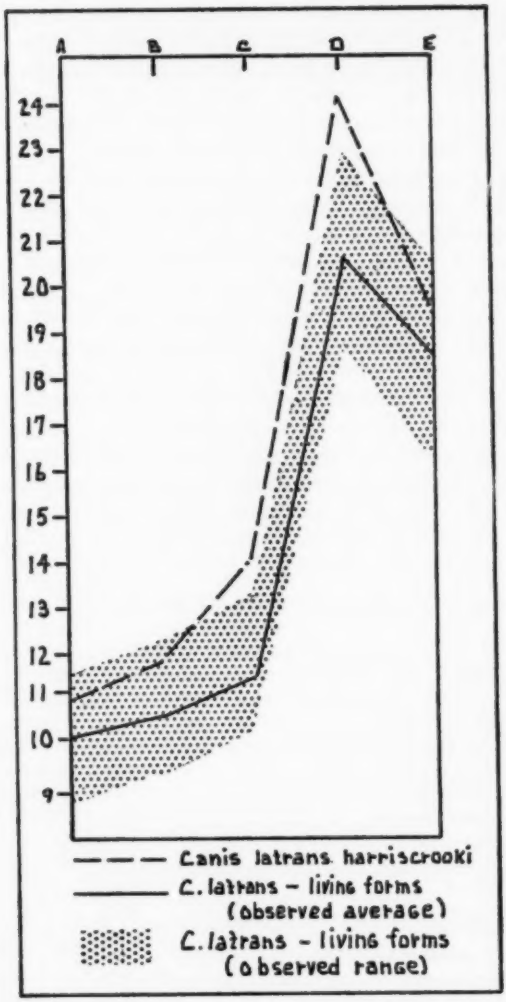

FIG. 1.—Graph showing anteroposterior diameters of teeth as follows: A, p_3; B, p_3; C, p_4; D, m_1. E shows depth of mandible at anterior edge of m_1.

Seifert, who measured and furnished other pertinent data from a series of Recent specimens deposited in the Chicago Museum of Natural History.

I am pleased to name this subspecies in honor of the collectors of the type specimen, who were the first to recognize the Pemberton Hill-Lewisville terrace and its various members.

Canis latrans harriscrooki new subspecies

Holotype.—Left lower jaw, complete except for incisors, third molar, condyle, and coronoid process. The specimen is deposited in the Museum of Paleontology, Southern Methodist University, Dallas, Texas, and carries the accession number, SMUMP 60315.

Locality and horizon.—Basal Upper Shuler member of the Pemberton Hill-Lewisville terrace of the Trinity River (Elm Fork); *Lewisville Site*, Denton County, Texas.

Diagnosis of subspecific characters.—The p_2 contains well-developed secondary cusp (or posterior tubercle) in addition to the cingulum. The premolar-molar series is generally longer relative to the depth of the mandible. The distance between the premolars is more reduced, and the ascending ramus is more vertical than in all living forms other than *C. l. hondurensis*.

Description.—The canine and mandible of the fossil approximate the average size of 80 adult individuals examined, representative of 12 living subspecies, while p_4 and m_1 are larger anteroposteriorly than any of the Recent specimens examined. It is certainly not suggested that the largest and smallest living individuals are represented in the Recent series examined, but Fig. 1 shows that the ratios in Recent jaws remain fairly constant whether the specimen is very small or rather large, and that the same ratios are quite different in the fossil. Also, in the fossil, the premolar-molar series is among the longest measured, even though the distance between the premolars is much less. All premolars other than p_1 contain well-developed secondary cusps in addition to strong cingula. The posterior heel of m_1 is more than one-third of the total length of that tooth, whereas it is less than one-third in all observed Recent specimens. The m_3 is closer to the ascending ramus than in observed Recent specimens and the ascending ramus is more nearly vertical than in all living types other than *C. l. hondurensis*. In these two latter features, the new race agrees with the pre-Sangamon species, *C. irvingtonensis* from California. See Table 1 and Plate I.

DISCUSSION

Considering the characters that Gidley (1914) used to separate coyotes from wolves and dogs, it is difficult to decide whether the new form is a wolf-like coyote or a coyote-sized wolf. Taking these characters one at a time, we find that *C. latrans harriscrooki* is really quite wolf-like, but considering the seemingly intermediate features in the living races, *C. l. hondurensis* (Central America) and *C. l. microdon* (southern Mexico), the new form is believed to be a *coyote* of a primitive type. The primitiveness of these characters is pointed up by the simi-

larity between the jaw of the new race and that of the Miocene genus, *Tephrocyon* (Fig. 2).

Gidley (1914) stated: "Thus in the true wolves and domestic dogs the heel of the lower carnassial [m_1] is short (being less than one-fourth the total length of the crown)" . . . . The m_1's in all Recent coyotes examined had posterior heels more than one-fourth of the total length of that tooth. In this, *C. l. harriscrooki* is more like the coyotes, but to the extreme. The heel is slightly more than one-third of the tooth's total length—a ratio not found in any Recent specimens examined. Gidley also said: "In wolves and dogs p_4 has but one secondary cusp and a

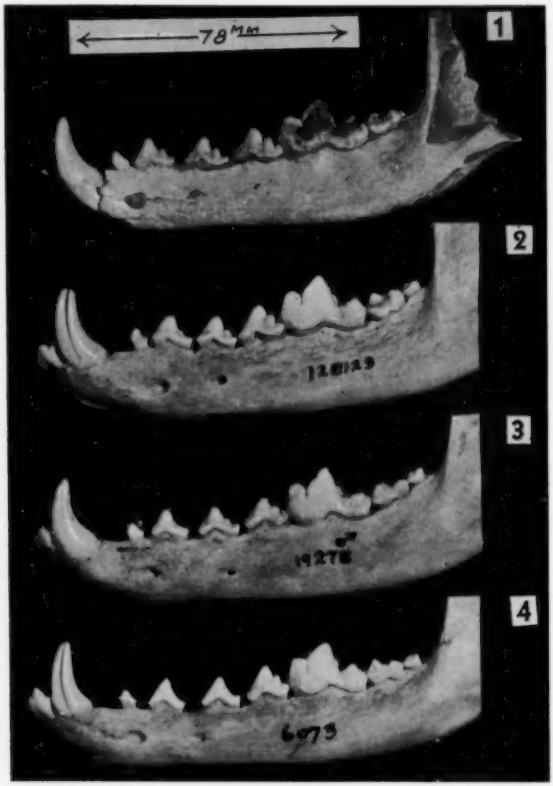

PLATE I

Holotype of *Canis latrans harriscrooki* and specimens representative of the three types that include most living forms. Specimens are lined up vertically on a line at the anterior edge of m_1, showing that longer premolar diastemas are caused partially by reduction of anteroposterior diameters of the premolars plus lengthening of the jaw itself. 1, *C. l. harriscrooki* n. ssp.; 2, *C. l. hondurensis*, Goldman, 128129 AMNH; 3, *C. l. cagottis*, (Hamilton-Smith), 19278 UK; 4, *C. l. microdon*, Merriam, 6073 LSU.

cingulum." According to Gidley, there is an extra cusp, in addition to the single secondary cusp mentioned above, present in coyotes. I found neither of these characters to be consistent. Nevertheless, in the new race, p_4 has two well-developed accessory cusps. Another of Gidley's key features is that "p_2 and p_3 usually contain well-developed posterior secondary cusps in wolves and dogs." In living coyotes, p_2 almost never contains the accessory cusp, and p_3 often lacks the element. These cusps are strong in both p_2 and p_3 of *C. l. harriscrooki*. Not only is this true in the holotype, but in the only other two known Late Pleistocene specimens from Texas that have these teeth preserved. One is from an unknown locality on the Brazos River, found in association with elephant, and the other is from the famed Ingleside locality. Both are deposited in the collection of the Bureau of Economic Geology, University of Texas, Austin. This cusp was present on p_2 in but 3 of 28 Recent specimens examined from Central Mexico southward. Two were *C. l. microdon*, from San Luis Potosi, Mexico, and the other was *C. l. hondurensis*, from Archaga, Honduras. None of these has the extra cusp as well-developed as it is in the Denton County fossil, and the remnant cusp is present on but one side in the Honduras specimen. Not a single one of the 52 coyotes and 7 "red wolves" examined from the United States, possesses this cusp. Complicating the significance of this primitive feature in the Texas fossils, are the two earlier species, *C. lepophagus* from Cita Canyon (Blancan) and *C. irvingtonensis* (prebison); both of these lack the secondary cusp on p_2 like most of the specimens of the living races. Perhaps the earlier species represent a lineage separate from the living forms and gave rise to a now extinct form terminating with the wolf-sized canid, *C. armbrusteri* from the Cumberland Cave in Maryland. Or it may be that the presence of the cusp is indicative of a southern form, present this far north only during an interglacial or interstadial. A type more like the vast

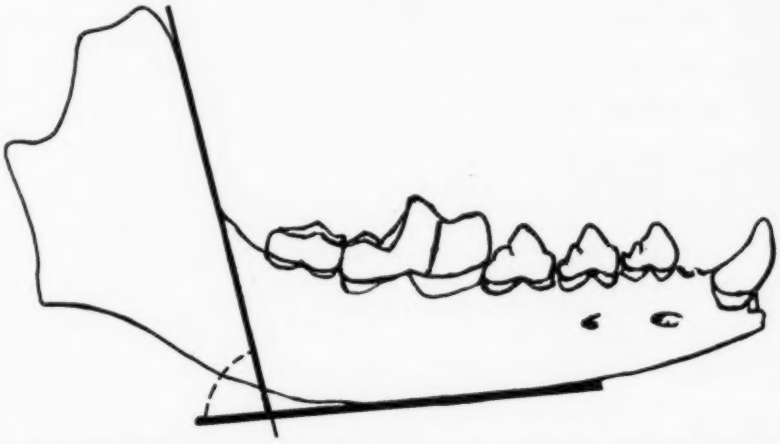

FIG. 2.—Sketch of the lower jaw of the Miocene genus *Tephrocyon*, showing the method used in measuring the angle of the ascending ramus.

majority of the living races may have occupied most of North America during cooler periods. *C. orcutti*, the Wisconsin species, described from Rancho La Brea, does not possess the second cusp on p_2. The possibility that *C. l. harriscrooki* represents a more southerly form is certainly not negated by its associated fauna: armadillos, tapir, and *Geochelone*.

We may add, to Gidley's list of coyote-wolf characters, the angle of the ascending ramus (Fig. 3). This angle is decidedly more vertical in *C. lupus* than in *C. niger*, or in all living races of coyote other than *C. l. hondurensis*, and most dogs. Here, again, we have a wolf character present, not only in the new holotype but also in the only other Late Pleistocene specimen from Texas which has this portion preserved. The specimen is from Trinidad, Texas, 80 miles downstream from the type locality of *C. l. harriscrooki*. The collection locality of this specimen was reported by Stovall and McAnulty (1950) and was equated with

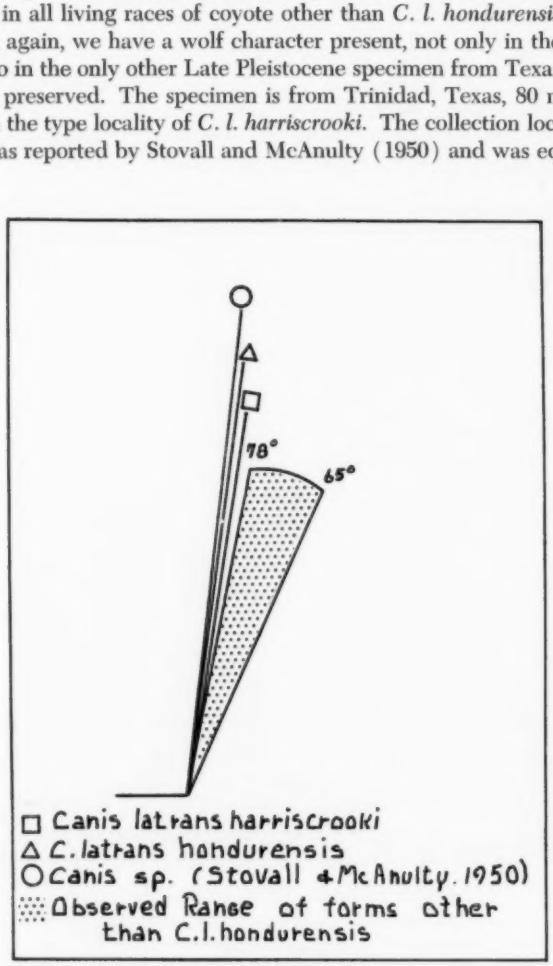
78°
65°
□ Canis latrans harriscrooki
△ C. latrans hondurensis
○ Canis sp. (Stovall & McAnulty. 1950)
Observed Range of forms other than C.l.hondurensis

FIG. 3.—Angle of ascending ramus. Shaded area represents range demonstrated in 80 examined specimens of *C. l. cagottis, clepticus, frustror, goldmani, impavidus, latrans, lestes, mearnsi, microdon, ochropus, texensis*, and *thamnos*.

the Pemberton Hill-Lewisville terrace in Denton and Dallas County by Slaughter *et al.* (1961).

CONCLUSIONS

Not a single Recent or described fossil specimen contains all of the characters cited here as subspecifically diagnostic. Three individuals from localities in southern Mexico and Honduras do share some of the characters of the Texas fossils, but weakly developed. On the other hand, all three Late Pleistocene Texas jaws are clearly referable to the new race; the Brazos River and Ingleside jaws, on the basis of the secondary cusps on p_2, and the Trinidad specimen of Stovall and McAnulty, on the basis of the more vertical ascending ramus. Because of the possibility that the differences between the living races and the extinct form may be temporal rather than geographic, it seems well to refer the fossil type to the living species, giving it the rank of a new subspecies.

As the recognized living subspecies have not been found in the Late Pleistocene deposits of Texas, it will prove important to watch for the oldest specimen referable to one of these races. Whether the living coyotes prove to be products of rapid late or post-Sangamon evolution, or replacement of an older form by a new immigrant, it could become a useful stage indicator. Coyote jaws from Late Wisconsin deposits are needed to settle this point.

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POPULATION CHANGES OF CARNIVORES IN SOME COYOTE-CONTROL AREAS

By Weldon B. Robinson

Abstract: In 1940 and 1941 records were maintained of animals trapped during predator-control operations in seven localities in New Mexico, Colorado and Wyoming. Traps were set for coyotes, *Canis latrans*, and bobcats, *Lynx rufus*, but such animals as badgers, *Taxidea taxus*, skunks, *Mephitis mephitis*, raccoons, *Procyon lotor*, and swift foxes, *Vulpes velox*, were unavoidably trapped. The studies were repeated in 1951 and again in 1960, and the catch-records are used to indicate the population levels of the commonly trapped carnivores at the three 9–11-year intervals. It is recognized that variations in numbers of these animals probably occurred annually and that the catch-records reported here serve only as rough indicators of population status or trends.

In four areas in Colorado and New Mexico, coyote numbers declined from 1940–41 to 1951, then increased in 1960. The population trends of bobcats, skunks and raccoons were generally in the reverse direction, with the largest catches in 1951. Badgers and swift foxes continued to increase over the 20-year period. In the three Wyoming areas, the coyote population dropped in 1960 to 8 per cent of its 1940–41 level while numbers of the other carnivores increased sharply. More than 25 times as many bobcats, 3 times as many skunks, and 8 times as many badgers were caught in this state in 1960 as 20 years ago; 9 raccoons also were trapped in 1960 where none was taken in 1940–41.

There were changes in the population levels of coyotes and of some or all of the other carnivores during each of the 10-year periods in each of the three states. The causes of the changes in the numbers of other carnivores are obscure, but it is evident in each case that the level of coyote control which was applied did not hold down the populations of these other animals.

Data showing the population trends of many of our wild animals are lacking. Records of hunter take, fur sales, annual censuses, or control programs give some indication of the changes in numbers of those animals that man considers so valuable, so scarce, or so harmful as to be managed, but such criteria are not available for measuring the population trends of other groups. Representative of these other groups whose numbers are watched less closely are the carnivorous mammals found in association with coyotes, *Canis latrans*, in the deserts and plains of the West. These are in general the long-haired furbearers which have lost their status as valuable fur animals and, with that, much of the attention they otherwise would have received.

The Bureau of Sport Fisheries and Wildlife has collected records which indicate the relative population levels of coyotes and associated carnivores in selected localities at three intervals during the past 20 years. The data were collected in connection with coyote-control work, and therefore the control methods used are given as a part of the over-all picture.

METHODS

In 1940 and 1941, selected trappers of the Branch of Predator and Rodent Control, working cooperatively with the Denver Wildlife Research Center, recorded on a set-day basis the various animals taken with coyote-getters and

steel traps in 11 representative predator-control areas in Wyoming, Colorado and New Mexico (Robinson, 1943). At that time, 82,820 trap-set days (either one or two traps to the set) and 107,215 coyote-getter days of activity were recorded during all months of the year. The purpose of the study was to determine the advantages and disadvantages of the coyote-getter as a control implement and to compare it with the steel trap, but a valuable by-product was to establish a basis for judging the relative numbers of the larger carnivorous mammals inhabiting the study areas at that earlier time. Even though the steel traps were set for coyotes and, to a lesser extent, for bobcats, *Lynx rufus*, such animals as badgers, *Taxidea taxus*, skunks, *Mephitis mephitis*, and raccoons, *Procyon lotor*, were unavoidably trapped. The frequency with which such animals were later trapped reflects the general population trend.

The trapping studies were repeated in 1951 following several years of restricted use of steel traps and expanding use of coyote-getters and 1080 stations in coyote-control work. Seven of the 11 localities in Wyoming, Colorado and New Mexico, trapped experimentally in 1940 and 1941, were retrapped during late summer and autumn when conditions were most favorable. The selection of areas in 1951 was determined solely by the availability of competent trappers in each area who could be assigned to the study. The procedures were the same as in the earlier period. The Denver Wildlife Research Center supervised the study; designed and provided the necessary data-recording sheets; and listed the areas to be trapped, the number of trap-sets to be employed in each area, and the periods of trapping. The Branch of Predator and Rodent Control assigned competent Mammal Control Agents to trap for coyotes in the specified areas during the specified periods; the trappers maintained a record sheet for each trap-set and recorded the activity each time the set was attended. Based on animals taken per trap-set day, the data disclosed that coyote numbers had decreased, and this was attributed to the control program. During the same periods and in the same areas, however, the populations of skunks, badgers and raccoons had increased (Robinson, 1953).

The studies were carried out for a third period of time in 1960 with the areas trapped, the timing, and other procedures of the previous periods being followed closely. It would have been desirable for the same fieldmen to have trapped the seven areas each time data were collected, but this was possible in only one area and for only two of the three study periods. In all other instances different trappers were involved. This would not seem to be a serious handicap, as coyote-trapping techniques are fairly uniform and deviations were held to a minimum through supervision by competent Bureau representatives.

There was an attempt in 1951 and again in 1960 to duplicate as closely as practical the trapping operations carried out in 1940–41. To do this, it was necessary at times during the later periods to set traps in areas where coyotes were less abundant than before. Thus, where there was no coyote sign, the traps had to be set on the basis of knowledge of coyote habits, i.e., where they probably would be if they were present in larger numbers.

RESULTS

The numbers of carnivorous mammals trapped in the seven localities are given by states in Table 1. The lists of animals include not only those creatures that were killed or released from traps but also a few that escaped under conditions permitting identification. In the early 1940's the coyote-getter largely replaced the steel trap in coyote-control work in these areas. The history of employment of other major control methods is given for each locality.

New Mexico.—The single trapline in this state was 78 miles long and covered parts of eight townships north of Clayton in Union County. Compound 1080 stations have been used for the control of coyotes in this locality since the winter of 1948–49, but apparently have become less effective during recent years. The expanding activities of people into the more remote areas also has tended to limit the use of coyote-getters.

In 1941, 14 coyotes and 7 bobcats were trapped on this New Mexico line; the catches dropped sharply to no coyotes and 1 bobcat in 1951, then increased to 16 coyotes and 6 bobcats in 1960. The trend in badger populations, as indicated by the numbers caught, was upward from 1941 to 1951, and it had leveled off by 1960. The catches of both skunks and raccoons followed a different pattern: low in 1941, high in 1951, and low again in 1960. The same supervisor worked with the local mammal control agents in establishing the traplines in 1951 and in 1960, and therefore deviations in trapping techniques should not have been a reason for the fluctuating catches during these periods.

Colorado.—Three traplines were operated in Colorado: (1) a 55-mile line crossing parts of 10 townships in the Great Divide country north of Craig in Moffat County; (2) a 63-mile line touching 7 townships in the San Luis Valley in Alamosa and Costilla Counties; and (3) a 40-mile line covering parts of 5 townships between Pueblo and Colorado Springs in Pueblo and El Paso Counties.

Compound 1080 stations were first used in Moffat County during the winter of 1945–46, in the San Luis Valley the next winter, and in the Pueblo-El Paso County study area during the winter of 1947–48. Their use was discontinued in the Pueblo-El Paso County area in 1955, but such stations have been used continuously to the present time in the other localities. However, as in New Mexico, this coyote-control procedure is considered by local personnel of the Branch of Predator and Rodent Control to be less effective than before, and the use of coyote-getters has been restricted because of the dangers to people.

The trapping records indicate that coyote numbers in the three Colorado districts dropped 55 per cent from 1940 to 1951, then increased in 1960 to the level of 20 years ago. The trend in bobcat numbers was in the opposite direction: the catch was low in 1940, high in 1951, and low again in 1960. All but 2 of the 16 Colorado bobcats taken in the study were trapped in Moffat County, and the same trapper operated that line the last two periods; he caught 11 bobcats in 1951 but only 2 in 1960.

The skunk population in the Colorado study areas apparently has remained reasonably stable. Badger numbers have been in an upward trend, with the 1960

TABLE 1.—*Trapping records from three states at three 10-year intervals*

	Trap-set days and	NEW MEXICO*			COLORADO†			WYOMING‡		
		1941	1951	1960	1940	1951	1960	1940–41	1951	1960

TABLE 1.—*Trapping records from three states at three 10-year intervals*

Trap-set days and species trapped	NEW MEXICO*						COLORADO†						WYOMING‡					
	1941		1951		1960		1940		1951		1960		1940–41		1951		1960	
	No.	Index	No.	Index	No.	Index	No.	Index	No.	Index	No.	Index	No.	Index	No.	Index	No.	Index
Trap-set days	2625		2759		2734		4134		3851		3874		9491		9681		9913	
Carnivores:																		
Coyote, *Canis latrans*	14	100	–	–	16	110	26	100	11	45	24	99	37	100	7	19	3	8
Bobcat, *Lynx rufus*	7	100	1	14	6	82	1	100	13	1396	2	213	3	100	8	261	80	2553
Skunk, *Mephitis mephitis*	3	100	10	317	–	–	7	100	4	61	5	76	20	100	34	167	70	335
Badger, *Taxidea taxus*	3	100	10	317	10	320	9	100	13	155	18	213	14	100	28	196	130	889
Raccoon, *Procyon lotor*	2	100	16	761	2	96	–	–	–	–	1	–	–	–	2	100	9	439
Swift fox, *Vulpes velox*	–	–	–	–	1	–	1	100	–	–	8	854	–	–	–	–	–	–
Red fox, *Vulpes fulva*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–
Weasel, *Mustela frenata*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–
Others:																		
Rabbit, *Lepus townsendi, L. californicus* and *Sylvilagus auduboni*	–		20		1		10		23		36		79		85		53	
Porcupine, *Erethizon dorsatum*	9		5		2		3		1		3		4		23		16	
Prairie dog, *Cynomys ludovicianus*	–		–		–		–		–		–		2		–		–	
Kangaroo rat, *Dipodomys ordi*	–		5		–		–		1		–		–		–		–	
Wood rat, *Neotoma* spp.	–		–		–		–		–		–		–		1		1	
Ground squirrel, *Citellus* sp.	–		2		–		–		–		–		–		–		–	
Pronghorn, *Antilocapra americana*	–		–		–		–		–		2		1		–		3	
Deer, *Odocoileus hemionus*	–		–		–		–		–		–		1		3		21	
Pheasant, *Phasianus colchicus*	–		–		–		–		–		–		5		–		–	
Sage grouse, *Centrocercus urophasianus*	–		–		–		–		2		1		–		–		1	
Golden eagle, *Aquila chrysaetos*	–		–		–		–		1		–		–		–		3	
Great horned owl, *Bubo virginianus*	–		–		–		–		–		–		–		1		1	
Red-tailed hawk, *Buteo jamaiiensis*	–		–		–		–		–		–		–		–		1	
Turkey vulture, *Cathartes aura*	1		–		–		–		–		–		–		–		–	
Magpie, *Pica pica*	–		–		–		–		2		2		1		1		5	
Domestic sheep	1		–		–		11		–		–		6		1		21	
Domestic calf	–		1		–		–		–		–		–		–		–	
Domestic dog	–		3		–		2		–		–		4		3		4	
Domestic cat	–		2		–		1		–		–		1		1		1	

* Union County.

† Three localities in Moffat, Alamosa and Costilla, and Pueblo and El Paso Counties.

‡ Three localities in Niobrara, Sheridan, and Niobrara and Converse Counties.

catch double that of 1940. Eight times as many swift foxes, *Vulpes velox*, were trapped in 1960 as in 1940, but the relationship of the increase of these animals to the control of coyotes and to the control methods used is clouded by the fact that all of the swift foxes caught in 1960 were taken in a locality where 1080 stations were not used the preceding 4 years; coyote-getters, however, were used intermittently during that period, with extensive coverage during the last year.

Wyoming.—The traplines in this state were: (1) a 120-mile line crossing parts of 18 townships north of Casper in Natrona and Converse Counties; (2) a 95-mile line through 16 townships northwest of Lusk in Niobrara County; and (3) a 68-mile line across 12 townships northeast of Sheridan in Sheridan County.

Coyote control procedures have been similar throughout the three areas. Thallium stations were first used on a limited basis during the winter of 1941–42, with complete coverage being reached by the winter of 1944–45. Thallium was gradually replaced with 1080 in the late 1940's, and that lethal agent has been used continuously to the present time. In addition, during recent years shooting from airplanes has supplemented the other control procedures in the deserts and plains of Wyoming. Thus the most intensive type of coyote control, including the wide use of lethal stations, has been carried out in the study areas of this state since the first trapping data were recorded in 1940 and 1941.

The coyote population in the three areas—as indicated by the numbers of coyotes trapped—dropped in 1960 to 8 per cent of its 1940–41 level. At the same time the populations of the other carnivorous mammals have been in a sharp upward trend: more than 25 times as many bobcats, 3 times as many skunks, and 8 times as many badgers were caught in 1960 as in the 1940–41 period. The change in the numbers and habits of bobcats seems most striking. In addition to being many times more plentiful, these animals now are ranging away from the rougher sections and are being trapped in the open where they were seldom taken 20 years ago. Raccoons have spread into all three areas, with 9 being trapped in 1960 compared to 2 in 1951 and none in 1940 and 1941. Most of the traps in which these animals were caught were baited with natural coyote scent in an effort to make the trapping for coyotes as selective as possible.

Other animals trapped.—The other mammals and birds unintentionally caught in the coyote traps during the three periods also are listed in Table 1. Excluding the domestic animals, the only creatures taken so frequently as to suggest trends in their numbers were the "rabbits" (primarily *Lepus townsendi* and *L. californicus*, with smaller numbers of *Sylvilagus auduboni* included), porcupines (*Erethizon dorsatum*), deer (*Odocoileus hemionus*) and pronghorns (*Antilocapra americana*). The numbers of rabbits trapped fluctuated locally, no doubt in response to cycles; throughout the seven localities, 89 rabbits were trapped in 1940–41, 128 in 1951, and 90 in 1960. Porcupines were caught in all three states, with 16 taken in 1940–41, 29 in 1951, and 21 in 1960. Although most deer and pronghorns that step in coyote traps promptly pull out, some are held. These game animals are now so abundant in the study areas, especially in Wyoming, that quite a few were unavoidably trapped.

SUMMARY AND CONCLUSONS

Assuming that the catch-records are indicative of the general numbers of the commonly trapped animals, their population trends can be traced over a 20-year period. On this basis, from 1940–41 to 1951 coyote numbers declined in the study areas in all three states, as a result of the use of new control methods. At the same time populations of bobcats, skunks, badgers and raccoons were in a general upward trend; the only exceptions were that fewer bobcats and skunks were trapped in New Mexico and Colorado, respectively, during the later period.

From 1951 to 1960, coyotes increased in the four study areas in New Mexico and Colorado. Populations of the other carnivores in these localities then showed varied trends: skunks and raccoons decreased while badgers increased. There also was a sharp upswing in swift fox numbers. In the Wyoming study areas, coyote numbers continued to decrease during this decade. At the same time the trends in the populations of bobcats, skunks, badgers and raccoons continued upward to the point where these animals, as a group, were more than three times as plentiful in 1960 as in 1951 and more than seven times as plentiful as in the 1940–41 period.

The data show that there were changes in the population levels of coyotes and of some or all of the other carnivores during each of the 10-year periods in each of the three states. The causes of the changes in the numbers of the other carnivores are obscure, but it is evident in each case that the level of coyote control which was applied did not hold down the populations of these other animals.

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SOME FOOD HABITS OF THE MARTEN

By Adolph Murie

Abstract: From an analysis of scats, the food habits of the marten were obtained in 3 habitats in Grand Teton National Park. Haw, Oregon grape, blueberry and rhamnus berries were important vegetable food items where available. Voles were the most prominent meat item in the diet. The red squirrel was rarely eaten, but its home was often used for lodging.

Over a period of years, 528 scats of the marten, *Martes americanus caurina*, were collected in Grand Teton National Park, Teton County, Wyoming. Of these, 121 were gathered along trails that penetrate the various canyons; 23 were collected in the forest where it adjoins the open sagebrush country; and 384 were gathered in a wooded area along the Snake River. The three areas differ in respect to some of the food items available to the marten so will be discussed separately. The scats were analyzed dry, or, if necessary, by soaking them first in water.

Food habits in the canyons.—The 121 scats from the canyons leading into the Teton Range were gathered rather casually in 7 different years between 28 July and 5 October. The majority of them are from Cascade Canyon; a few were collected in Paintbrush, Death and Granite canyons.

In Table 1 is listed the number of scats in which each food item occurred. Voles, as one would expect, were eaten extensively. They were found in 35 of the 121 scats. Four species of *Microtus*, *Phenacomys* and *Clethrionomys* were available in this general category. The jumping mouse (*Zapus*), abundantly available in some years, was present in 15 scats. The deer mouse (*Peromyscus*), rather common, was found in only five scats. The ground squirrel (*Citellus armatus*) was scarce and its remains were noted in only one scat. The chipmunk (*Eutamias*) and the golden-mantled ground squirrel (*Citellus lateralis caryi*) were present in eight and four scats, respectively. The red squirrel (*Tamiasciurus*) was recorded in only one scat.

The marten apparently is able to make of cony (*Ochotona*) hunting a successful project, for cony remains were found in 16 scats. I often saw marten sign in cony habitat. Once I observed a marten in an extensive rock slide in the Wind River Mountains of Wyoming at an elevation of about 13,000 feet, and a half-mile or more beyond the nearest timber. When first seen the marten was alertly watching and listening, and not far off conies were calling. It was obviously interested in the conies. But then it took fright and hurried off among the rocks, appearing and disappearing as it traveled. A prairie falcon dived at it and caused it to dart for cover. The slide rock furnishes cover as well as conies for the marten.

The snowshoe rabbit (*Lepus americanus*) was not abundant and was present in only one scat. The pocket gopher (*Thomomys*), occurring in six scats, is a secondary but regular food item where it is present. Shrews (*Sorex*) are apparently not much relished and are only occasionally eaten. Their remains were noted in only one scat. The occurrence of bird remains in six scats indicates that

TABLE 1.—*Food items represented in 121 marten scats gathered on the canyon trails in the Teton Mountains; in this and following tables, figures indicate the number of scats in which the various food items were found*

Voles	35	*Sorex*	1
Ochotona	16	Bird	6
Zapus	15	Eggshell	1
Eutamias	8	Grasshopper	4
Thomomys	6	Wasp	3
Peromyscus	5	Beetle	1
Citellus lateralis	4	Blueberry	51
Lepus americanus	1	Mountain ash	8
Citellus armatus	1	Serviceberry	1
Marmota	1	Pine nuts	3
Tamiasciurus	1		

birds were eaten to only a nominal extent. Grasshoppers, wasps and beetles made up considerable portions of a few scats, indicating that such insects could become more prominent in the diet under some circumstances.

Blueberries (*Vaccinium membranaceum*) were present in 51 of the scats and made up 100 per cent of 21 of them. Mountain ash berries (*Sorbus*) were found in eight scats and made up 100 per cent of the contents of three of them. The marten is fond of many species of berries and feeds on them from preference. Nut remains from white-barked pine, and perhaps also limber pine, occurred in three scats and made up the larger part of one of the scats.

Food habits at edge of woods.—A family of martens was raised in a woodshed located in a spruce-lodgepole pine forest near the open sagebrush country. On 4 August I gathered 23 scats in the building that the martens had occupied. This habitat differed from the other two in the presence of many ground squirrels. The number of scats is insufficient for an analysis of the marten food habits in the area, but does suggest that the ground squirrel is a vulnerable species when available. Its remains were found in nine of the 23 scats. The food items found in the scats are listed in Table 2.

Food habits in Snake River woods.—In the woods along the Snake River about ½ mile below the Moose postoffice, 384 marten scats were gathered, most of them in 1957 and 1958. On short walks at my home I kept alert for marten scats

TABLE 2.—*Food items represented in 23 marten scats gathered in the edge of the forest near the old park headquarters*

Citellus armatus	9	*Neotoma*	1
Voles	4	*Ochotona*	1
Peromyscus	3	Small bird	2
Eutamias	3	Beetle	1
Sorex	2	Blueberry	2
Thomomys	1		

and usually found a few each day along the trails. Occasionally I searched more extensively by following short sections of moose trails, examining the more prominent down-logs used by martens in their travels, and visiting red squirrel middens. There was the usual tendency to deposit additional scats where there already was one or where one had been. They are frequently left on rocks, on a log crossing a trail, or on large roots in the trail. In order to obtain scats in marshy areas where martens came to feed on rhamnus (*Rhamnus alnifolia*) berries I placed two or three boards for dropping stations, but succeeded in securing only a few scats in this manner. After the snow covered the ground and down-logs, very few scats were found although I did considerable trailing. Occasionally in winter a scat was left at a bird-feeding station visited by the marten to feed on the suet. Much of the hunting activity in winter takes place under the snow. Most of the scats were gathered from about mid-August to early December. About one square mile would include the area in which the scats were gathered. The number of martens present was not closely determined, but for one period an adult with two young, and a larger and brighter-colored animal that may have been the male, were known to be present. Food items in scats from this area are summarized in Table 3.

The woods consisted of a mixture of spruce, fir, lodgepole pine, aspen and cottonwood growing in open and dense stands. Numerous windfalls enriched the habitat from the standpoint of cover. An extensive stand of black haw (*Crataegus douglasi*) grew along a small creek. Two sedge swales and some grassy areas provided much vole habitat, and in the wet swales grew extensive patches of rhamnus, a low shrub that for a few weeks furnished the chief source of the marten's diet. Blueberry was scarce or absent. On one side of the area, where the scats were collected, was a stand of widely spaced, large cottonwoods. Here tracks in the snow, leading from one tree to another, were frequently seen in winter.

Remains of voles were found in 251 of the 384 scats. Three species of *Microtus* and *Clethrionomys* were present, but very few of the latter were identified in the scats. A few *Peromyscus* were no doubt eaten but I did not recognize any of their

TABLE 3.—*Food items represented in 384 marten scats gathered in the woods along the Snake River*

Voles	251	Eggshell	2
Thomomys	22	Fish bones	1
Eutamias	6	Insect	2
Glaucomys	2	*Crataegus*	121
Tamiasciurus	1	*Rhamnus*	44
Lepus americanus	1	*Berberis*	19
Sorex	1	Blueberry	1
Mouse nest	2	Snowberry	1
Bird	18	Pine cone	2
Bonasa	5	Suet sack	5

remains. I also failed to find remains of *Zapus* in the scats although a few of these mice were in the area. Voles of the genus *Microtus* were so readily available that the pressure on other rodents was probably not great. During the periods that berries were present, they were eaten to about the same extent as the voles.

Pocket gopher (*Thomomys*) remains were found in 22 scats. The gophers were plentiful over parts of the area during the period that the scats were collected. They are quite active in winter under the snow so apparently are available to some extent all year.

Chipmunk remains were present in only six scats. The chipmunk was so abundant around the ranch buildings that I expected its remains to appear more often in the scats. It might here be noted that ground squirrels were absent from this study area.

Flying squirrel (*Glaucomys*) remains were found in two scats and part of a carcass was found cached. It was difficult to determine the abundance of these squirrels. On a few occasions one was noted at the cabin, apparently attracted by a bird-feeding station, and a few of their tracks were observed in the snow in winter out in the open stand of large cottonwoods.

The red squirrel was especially abundant in the area, but its remains were present in only one scat. Fur remains of a red squirrel on the snow that was tracked up by a marten indicated another capture. At our bird-feeding stump one morning a marten made a sudden appearance at the entrance of a snow tunnel only 10 feet from a feeding squirrel; the squirrel scurried over to a nearby spruce tree and the marten watched it go. Although the marten ate few squirrels, it nevertheless had intimate associations with them. Much of the year it is an itinerant, stopping a day or two in an area and then moving on. For its lodgings it generally, at least frequently, moves in on a red squirrel, no doubt taking over the choicest nest available. The squirrel is not driven away but apparently uses one of its spare nests. A marten frequently lodged at a squirrel home adjacent to the extensive haw orchard. One sojourn must have been for a few days duration, for 15 fresh scats were deposited there, half of them just outside the burrow in the middens that it had taken over. Although the marten was a regular visitor, this squirrel apparently survived the winter. I judged that it was the same squirrel at these middens throughout the winter because of its special tameness.

On 8 November 1957 I found six fresh scats at another squirrel home. Apparently I had disturbed the lodger for, 6 feet from me, the head and shoulders of a marten emerged from an entrance. It commenced a series of deep, purring growls, seeming to be threatening me, and in its high temper bit a stick. It soon retired and did not appear again. One marten usurped a squirrel nest built on a shelf in one of our cabins. It lay on top of the nest rather than in it. Since it was June, there was no need for the warmth of the nest. Eleven fresh scats had been deposited in one spot on the floor of the cabin.

Remains of snowshoe rabbit were present in only one scat. Relatively few rabbits were in the area.

Shrew remains were present in one scat. Shrews were common in the area.

A few ruffed grouse (*Bonasa*) were year-round residents. Their remains were found in five scats. On four occasions remains of a grouse that had been fed upon by marten were noted over a period of 5 or 6 years. Often tracks in the snow showed that a marten had turned at a sharp angle to investigate an old snow tunnel of a roosting ruffed grouse. Once it had detected a grouse tunnel 25 feet to one side of its course. When the grouse breaks out of its snow tunnel the night's accumulation of droppings is exposed and it is no doubt the scent of the droppins that attracts the marten. On one occasion a marten dropped on its trail a grouse scat that it had been carrying and which it had picked up at a roosting tunnel.

Remains of birds other than grouse were found in 18 scats. No specific identifications were made except for that of a robin in one scat and a sparrow of some kind in another. Eggshell occurred in two scats. On two occasions in winter a marten captured a nutcracker (*Nucifraga columbiana*) at our bird-feeding station. The stump on which some food was placed was near the entrance of a snow tunnel which made it possible for the marten to make a surprise attack. Our attention was sometimes called to the presence of the marten by the low rasping call of the Steller jay.

Insects occurred in only two scats.

Haw berries occurred in 121 of the 384 scats. In both 1957 and 1958 it was first found in the scats on 17 September, about the time that rhamnus berries, which had been fed upon extensively, were beginning to play out. From 17 September to 8 December, a period during which representative scats are available, the haw vied with the voles for popularity. In the 202 scats collected during this period, haw was present in 108 of them, and voles in 112. Comparing the numbers in which these two items made up 100 per cent of a scat (or occasionally with only a trace of another item present), we find that 76 contained about 100 per cent haw, and 59 contained about 100 per cent vole. During this period, rhamnus occurred in 26 scats (some deposited before 17 September) and Oregon grape in 15. Over half the diet for these fall months consisted of berries, chiefly haw. Haw was known to be eaten extensively up to 8 December, occurring in 42 of 62 scats gathered between 1 November and 8 December. Some haw is eaten during the winter months. At squirrel middens that were last visited in early December, I found five scats the following spring that contained haw berries. These were deposited sometime during the winter. The marten spent considerable time in the haws in winter and very likely was attracted there to some extent by this fruit.

During the period that the large, juicy, black, rhamnus berries were available they formed a prominent part of the diet. They were first noted eaten on 13 August and the last fresh scat containing these berries was found on 26 September. It was found in about half the scats during this period and it made up about 100 per cent of 30 of the 44 scats in which it was found. Ruffed grouse and flocks of robins also fed extensively on this fruit.

Oregon grape (*Berberis repens*) was found in 19 scats, making up all of the contents of five of them. Except for fresh scats found on 26 August and 10

January, all of the Oregon grape occurrences were between 7 October and 11 November.

Blueberry is highly relished by martens, but it was scarce or absent in the area. The one scat containing blueberry indicates that either a few bushes were present or that a marten had visited a blueberry bench just west of the area. Snowberries (*Symphoricarpos*) were abundant but were noted in only one scat.

The pine nuts present in two scats were probably from limber pine, possibly from some cones I had discarded at the cabin. Half of one of the scats was made up of pine nuts.

One winter a marten, along with magpies and jays, fed on a coyote carcass until it was gone. A net sack outside our cabin was used to hold suet for the birds. The marten often fed on the suet and inadvertently swallowed part of the sack, pieces of which were found in five scats.

Caching.—On 17 December 1950 I followed the trail of a marten that had dragged a ruffed grouse about 200 yards and cached it in a hollow cottonwood. Apparently the grouse had been captured under a clump of spruces where a heap of droppings indicated it had been roosting. On 23 March, 1955 I noted that a marten had dug up the remains of a grouse that had been buried in the snow. In a cavity in one of the cottonwoods that a marten had climbed I found remains of a flying squirrel which it had apparently cached. On several occasions the marten carried off suet hung in a net sack for the birds. Once the sack containing the suet was dragged about half a mile to the big cottonwood, and I found the empty sack caught in the deeply furrowed bark of one of these trees, about 20 feet up.

Snow leaping.—In the open cottonwood forest, in winter, the marten frequently climbed lone cottonwoods and jumped 10 or 15 feet out from the trunk, leaving a deep mark in the snow. In one jump from a slightly leaning tree the marten landed 22 feet from the base of the trunk. Possibly the marten enjoys jumping, just as the otter does sliding. Twice I saw a marten jump to the snow from a spruce tree, from a height of about 15 feet. Once he jumped from the roof of a house to the snow 7 feet below. On another occasion a marten jumped horizontally about 6 feet and down about 3 feet and alighted on a sawed stump, 15 inches in diameter.

Crater Lake National Park, Medford, Oregon. Received 27 February 1961.

AGGRESSIVE BEHAVIOR IN DEER OF THE GENUS *ODOCOILEUS*

By I. McT. Cowan and Valerius Geist

Abstract: The aggressive behavior of three races of *Odocoileus hemionus* is described. Five separate elements are identified: crouch, nose licking, circling, snort, and rush. All of these are common to the three races but differences in detail are noted. The "snort" shows greatest diversity between races. Comparisons are drawn between the aggressive behavior of *Odocoileus* and certain other ungulates.

The colony of deer, maintained for study at the University of British Columbia, includes males of the following kinds. There are three adult *Odocoileus hemionus sitkensis* from southeastern Alaska, four young *O. h. columbianus* from Vancouver Island and three adults from California, two adult *O. h. hemionus* from central British Columbia, and two yearling *O. virginianus ochrourus* from the eastern part of that Province. These are penned individually under circumstances that permit easy observation of behavioral characteristics. All have been in captivity since one or two days old.

In all cervids some of the most exaggerated behavior, in terms of energy expenditure, posturing and intensity, is that accompanying the period of sexual excitement. This may be composed of actions directed toward the inanimate environment, action directed toward other males and actions directed toward the female.

We have been concerned with behavior in the first two categories. The group of animals under our observation are taxonomically closely allied and it would be expected that the basic patterns of aggressive behavior would be quite similar. We have, however, detected some reasonably constant differences between certain elements of aggressive behavior as evinced by the buck deer of the races in our herds.

Two forms of behavior have been directed toward the inanimate environment. Beginning at the time of velvet shedding, all animals undertake what appears as sham-fighting with the antlers against any yielding object in the environment. The yielding attribute is important; seldom are the antlers used against heavy stumps, stones or boles of large trees.

Early in the period the activity is mild and consists of lowering the head until the antlers are directed forward, then twisting, turning and pushing against the yielding object. There is little or no erector pili effect. Darling (1937) has imputed an erotic influence of this behavior upon the animal and describes masturbation as a frequent concomitant. No such involvement has been witnessed during ten years of close observation of *Odocoileus*. In fact, masturbation has not been seen under any circumstances.

The aggressive behavior of captive bucks seems to be directed equally toward other bucks and to human associates, or, in fact, toward any large moving object, especially if it is at a level just below that of the head of the deer. It has been our experience that under conditions of captivity attack behavior can reach an intensity at which it overrides sex interest toward the female and becomes the domi-

nant behavior to the extent that the unreceptive female may be vigorously attacked.

The aggressive behavior of the buck comprises several distinct components:

The crouch.—This involves a hunched posture, the hind legs are partially flexed, the shoulder and elbow joints are partially flexed with the combined effect of lowering the height of the animal. The flexure of the hind legs is greater than that of the forelegs, resulting in a low-rumped position. Erector pili effect is strong and muscle tonicity appears intense. The walk is slow, stiff and stilted, the head is held in line with the body, ears are laid back and turned with concave side exposed laterally. There is frequently a quivering of the tail, the whites of the eyes are exposed at the back of the opening. Figures 1 and 2 illustrate the normal posture and the crouch posture.

Nose licking.—There is constant licking of the nose in which the tongue is protruded alternately from each side of the mouth and flicked quickly upwards over the rhinarium.

Circling.—The aggressive male, separated from the object of his aggression, circles slowly in the crouch position, usually in clockwise direction. The action is strongly reminiscent of males of the dog family.

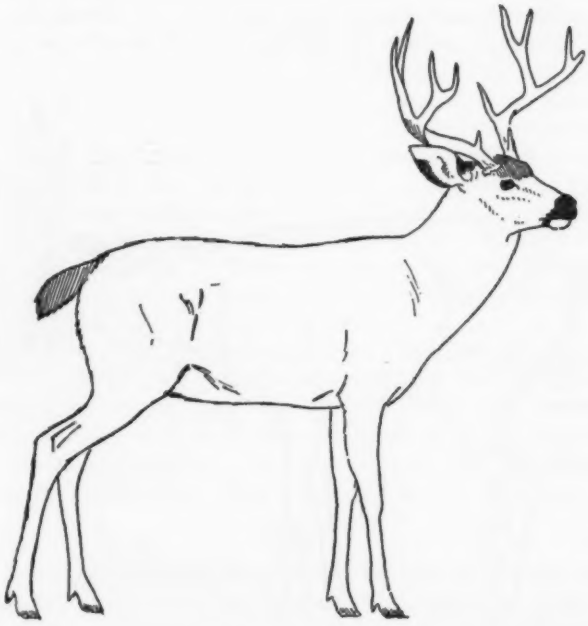

FIG. 1.—Male *O. h. columbianus* in normal posture.

The snort.—In its simplest form the snort occurs when the buck is circling in the crouch position. The neck is extended almost parallel with the ground, the head tilted downward; the preorbital glands are usually, but not always, opened widely. The upper lip is raised upwards at each side beneath the nostrils, which are held tightly closed. The snort is a prolonged, 5–10 second, sibilant expulsion of air through the closed nostrils, causing them to vibrate. It appears to involve considerable strain. The neck muscles bulge, the back may arch slightly, the hairs stand erect over the entire body and the tail is held outwards or upwards stiffly with the tip turned down. The flanks are pressed inwards. The buck is usually standing but many snort when walking. Usually the body is presented sideways to the object of the aggression. Figure 3 illustrates detail of the head during the snort.

This description is typical of the snort in the Californian individuals. There are differences between these and certain of the other racial stocks that are worthy of comment.

Behavior is most extreme in *O. h. sitkensis*. This form assumes the most exaggerated crouch and stiff-legged walk. The snort is frequently preceded by a grunt given with a slight uplift of the head, which is immediately pulled down into the snorting position. The snort finished, the nose is raised into a continuous forward line with the neck, then head and neck are thrown up with the emission of a loud grunt or groan. The pre-snort grunt may be missed, but the grunt afterwards is constant, and may be repeated up to five times in quick succession.

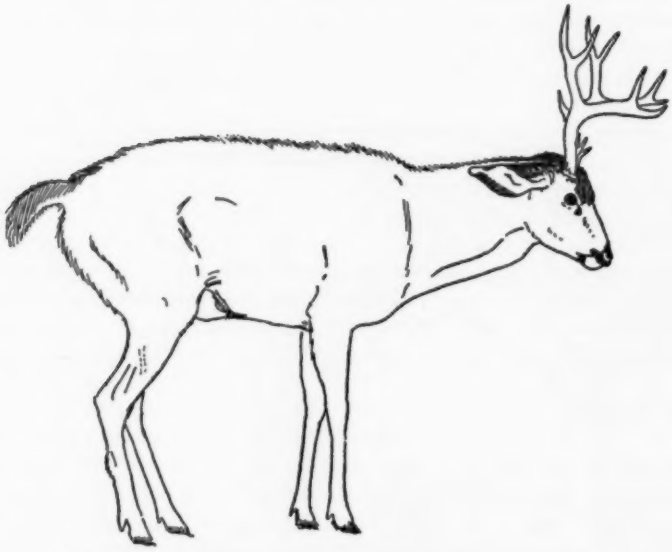

FIG. 2.—Male *O. h. columbianus*, aggressive posture, "crouch."

FIG. 3.—Male *O. h. sitkensis*, head details during "snort."

Our four-year-old buck *O. h. hemionus* is the quietest deer in the herd and seldom uses the aggressive patterns other than horning of yielding objects and sparring through the pen bars with an adjacent buck. A 20-month-old buck of the same race snorts frequently but has never used the grunt or groan before or after the snort. The older buck has been seen to snort while lying down.

The yearling bucks of *O. h. columbianus* have small antlers, clean of velvet, and have this year (1960) been in rut since about 1 December. Their snorting behavior is less formalized as to position. Their movements are more active, the crouch less extreme and the position of the head during the snort more variable. Frequently the head is up. The snort is followed by a prolonged inspirational groan, as if the throat were closed and the animal was having difficulty inspiring. In this race the tail is held up at a 45° angle.

The rush.—The culmination of aggression is the rush or lunge with head lowered to bring the antler points into contact with the object of aggression. The rush is pressed home with great vigor. We have had antler points penetrate completely through a ¼-inch fir plywood shield we use for protection when working with bucks during the period of sexual excitement. No differences have been observed between the rushing behavior of the different races.

DISCUSSION

In this series of elements in the aggressive behavior of *Odocoileus hemionus*, we can identify certain features common to other deer. Nose licking has been reported in *Cervus elaphus* (Heck, 1956) and was also observed in moose. One of our two whitetail bucks was observed to snort once. Severinghaus and

Cheatum (1956) report that white-tailed bucks in rut sometimes emit "muffled, snorting sounds." The short lunge or rush, bringing the antlers of the opponents into contact, is well known from red deer stags and has been observed in moose. The behavior patterns in horned artiodactyls, serving to bring the horns together, show a great variation (e.g., ramming in sheep, hitting from high up in goats, "hooking" in chamois, sideways clashing in oryx, kneeling and pushing in gnu).

The details of aggressive behavior in other species are meager but Walther (1958) has described behavior with apparently homologous elements in the nilgai, *Boselaphus tragocamelus*. In this species mutual threat between males is accomplished by a rigid, somewhat crouched posture. As in the blacktail deer, the ears are down but the white inside is not shown toward the opponent. While the neck is extended the head is held stiffly straight forward. The tail is held down, but jerks up periodically. In the blacktail it does not jerk up and down but may show intense quivering. As in the deer, rival nilgai bulls circle each other in this crouched, stiff posture, presenting the broad side to the opponent.

It is doubtful whether the differences in aggressive behavior as we have observed them in our animals are of significance in the survival of the race. It is probable, however, that they are heritable differences and are valid characteristics of the populations represented. More detailed analyses would be most desirable as would a wider base of comparison.

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Dept. of Zoology, Univ. of British Columbia, Vancouver. *Received 20 March 1961.*

GENERAL NOTES

SOREX LONGIROSTRIS IN SOUTHWESTERN MISSOURI

An adult male specimen of *Sorex longirostris* was taken by the writer, 31 March 1961, in southern Barry County, Missouri. C. H. Conaway aided in positive identification of the specimen. As far as can be determined, this represents the first valid record of the genus *Sorex* for the state.

The nearest marginal record of *S. longirostris* is from the vicinity of War Eagle, Arkansas (Sealander, J. Mamm., 41: 525–526, 1960). The distance between the sites of these two records is approximately 25 miles. However, both of these areas are over 200 miles west of any other locality where *S. longirostris* has been taken (Kellogg, Proc. U. S. Nat. Mus., 86: 245–303, 1939).

The area where this shrew was taken is the Ketchum Branch of Off Davis Hollow which flows into Roaring River near the southern boundary of Roaring River State Park. The trap site was under a small dolomite ledge in a semi-open glade area. These grassy glades are characteristic of certain portions of the White River drainage. Tall-grass prairie species and scattered red juniper predominate on the shallow soil of the glades (Kucera and Martin, Ecology, 38: 285–291, 1957). This habitat is quite arid throughout most of the summer months and standing water is present for only a short time following a rain at any time of the year.

Sorex longirostris has been associated with swampy or marshy areas throughout its range (Jackson, N. Am. Fauna 51, 1–238, 1928). However, five examples from Alabama were taken from upland old field communities some distance from water (Dusi, J. Mamm., 40: 438–439, 1959). Although Sealander (*op. cit.*) does not define the habitat where the northwestern Arkansas specimen was taken, there is little chance it was a swamp or marsh. These together with the specimen described in this paper indicate that at least some populations of the southeastern shrew are found in dry upland sites.

The museum skin and skull will be deposited in the U. S. National Museum.—L. N. Brown, *Dept. of Zoology, Univ. of Missouri, Columbia. Received 17 April 1961.*

A DENTAL ABNORMALITY IN *SOREX PALUSTRIS*

Examples are few of supernumerary, missing or fused teeth in the genera *Sorex* and *Microsorex* (see Jackson, N. Am. Fauna 51: 19–20, 1928), and anomalous teeth are supposedly rare in the family Soricidae as a group (see also Hall, J. Dent. Res., 19: 105–106, 1940; Hoffmeister and Goodpaster, Illinois Biol. Monogr., 24: 46, 1954; Jones, Trans. Kansas Acad. Sci., 60: 88–89, 1957; and Setzer, J. Mamm., 38: 258–259, 1957). Among soricids, there are to my knowledge no published records of a notably diminutive fourth unicuspid on only one side of the upper jaw, nor are there records of dental abnormalities in the species *Sorex palustris*. Hence the presence of a tiny, but firmly rooted, fourth unicuspid that is situated on the lateral margin of the right unicuspid row (Fig. 1) in a specimen of *S. palustris navigator* is here reported.

The specimen possessing this dental abnormality (KU 37306) is an adult male of average size that was obtained on 15 July 1950, from a place 13 miles north and 2 miles west of Afton, 6100 ft, Lincoln County, Wyoming. The dentition appears normal except that the fourth unicuspid on the left side is slightly smaller than average and the unicuspids on the right are slightly enlarged. The fifth unicuspid on the right possibly shows compensatory rotation counter-clockwise toward the abnormal tooth and anteriorly from the inner portion of the P^4, resulting in the formation of an inner and angular space between the P^4 and the fifth unicuspid. The anteroposterior length of this space at the lingual border of the toothrow is approximately twice that between corresponding teeth in the left row. All of the upper teeth on the right side that lie anterior to the abnormal unicuspid are situated more posteriorly than the corresponding teeth on the left side; thus the third right unicuspid, which is only slightly larger than the third left unicuspid, almost meets the fifth unicuspid on the lingual side of the abnormal

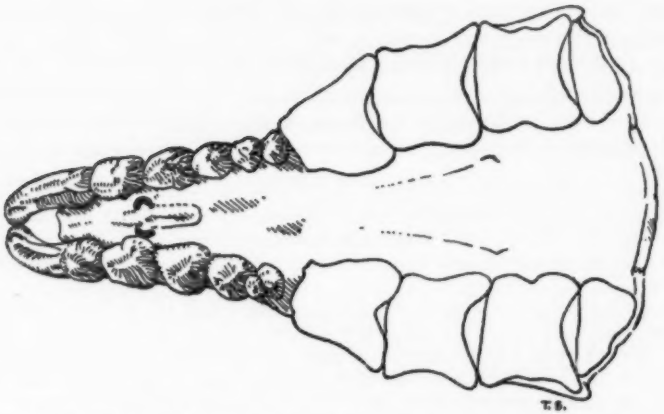

FIG. 1.—Abnormal dentition in *Sorex palustris*. No. 37306 KU, ♂, × 11.

tooth. The abnormal tooth has a single root, a cingulum, and an occlusal area that is approximately circular and less than half the size of that of the adjacent fifth unicuspid. The fifth unicuspid is normally the smallest of the maxillary teeth in *S. palustris*. Examination of the 155 additional skulls of *S. palustris* in the Museum revealed no other individuals having dental abnormalities. I thank A. B. Leonard and T. Swearingen for preparing the illustration.—CHARLES A. LONG, *Museum of Natural History, Univ. of Kansas, Lawrence. Received 13 February 1961.*

NEST CONSTRUCTION AND OXYGEN CONSUMPTION OF *CONDYLURA*

On 15 May 1958, the nest and two young of the star-nosed mole, *Condylura cristata*, were brought to the Department of Zoology, Michigan State University, by Allen Jeffrey of Haslett, Michigan. They had been taken from a nest containing five young, located on the north side of Lake Lansing, Ingham Co., Michigan, 30 cm beneath the ground and approximately 100 m from the water's edge.

The nest was spherical, 13 cm in diameter, and weighed 142 g air-dried, including some humus. It was constructed of leaves and was unlined. Leaves identified were those of cottonwood (*Populus* sp.), hawthorne (*Crataegus* sp.), willow (*Salix* sp.), and the red oak group (*Quercus* sp.). Hamilton (J. Mamm., 12: 345–355, 1931) summarized the scanty literature on the star-nosed mole to 1931 and I have been unable to find any more recent references to the nest construction. Hamilton reported that any locally available grasses or leaves are used in constructing the nest. In the present instance only leaves had been used.

The young were both males and weighed 22.6 and 20.7 g or approximately two-thirds of the weight at the time of weaning (Eadie and Hamilton, J. Mamm., 37: 223–231, 1956). They were completely furred and moved actively about in the container, emitting shrill cries when touched. At the time their oxygen consumption was measured the moles had been without food for approximately 24 hours.

The apparatus used to measure the oxygen consumption rates has been described elsewhere (Wiegert, Ecology, 42: 245–253, 1961). The larger of the two moles was placed in a mason jar animal chamber of the "short term" apparatus. The oxygen consumption was measured for one hour at a temperature of 28°C. During this time the animal was relatively active. The rate of oxygen consumption was 2.37 cc/g/hr.

The smaller mole was placed in the large chamber of the 24-hour apparatus but no food or water was provided. The oxygen consumption was measured (in cc/g/hr) at hourly intervals for 24 hours. The temperature was 27°C. These data, recorded as the mean rate per hour for two-hour period (1100–1300, 1300–1500, etc.) were as follows: 1200, 1.3; 1400, 1.3; 1600, 1.0; 1800, 1.1; 2000, 1.6; 2200, 1.5; 2400, 2.1; 0200, 2.3; 0400, 2.3; 0600, 2.6; 0800, 2.3; and 1000, 2.0.

Since diel variation in oxygen consumption can be used as a measure of activity levels (Wiegert, *op. cit.*) this particular mole was most active between 2300 and 0900. The total oxygen consumption for the 24-hour period gave an average value of 1.84 cc/g/hr.

After the 24-hour determination I attempted to feed the smaller mole with milk from a medicine dropper. It continued to lose weight, about one gram per day, and on the third day I prepared it as a specimen skin and skull. These have been deposited with the Museum of Zoology, Michigan State University, specimen number 5386.

The oxygen consumption rates reported here are lower than those which I have determined for young *Microtus pennsylvanicus* of a comparable stage of development (unpubl. data). This can be partially accounted for by the greater weight of the mole (20 g *vs.* approximately 8–10 g for similarly developed *Microtus*). The rates are also considerably lower than that reported for an adult *Condylura cristata* (Pearson, Ecology, 28: 127–145, 1947). The mole measured by Pearson weighed 60 g and was active during the measurement period. It had an oxygen consumption of 4.2–4.5 cc/g/hr. The lower rates reported in this note may be due to less activity in the animals I measured. Another possibility is that the homeothermal mechanism is not fully functional at this stage of development in *Condylura*. Thus a lower body temperature would be expected with a consequent decrease in the basal metabolic rate.—Richard G. Wiegert, *Dept. Zoology, Univ. of Michigan, Ann Arbor. Received 13 March 1961.*

THE PALE BIG BROWN BAT IN MANITOBA

In July 1956, 23 bats were shot as they were flying over a garbage disposal ground in the Whiteshell Forest Reserve of eastern Manitoba, about 80 miles east of Winnipeg. The collection contained 2 *Myotis lucifugus lucifugus*, 15 *Eptesicus fuscus fuscus*, 1 *E. f. pallidus*, 2 *Lasiurus borealis borealis* and 1 *L. cinereus*.

The specimen of *E. fuscus pallidus*, collected on 26 July, is of particular interest because it represents an eastern extension of about 400 miles of the known range of the subspecies, and is a first record of the animal in the Province of Manitoba (Hall and Kelson, The mammals of North America, p. 185, 1959). The record indicates a broad zone of overlap between the two subspecies with no evidence of intergrading. Measurements of the specimen, a mature male, were: 124; 51; 13; ear 14.5; tragus 8; forearm 53 mm; weight 20.9 g. The skin and skull have been deposited in the mammal collection of the Forest Biology Laboratory, Winnipeg, as specimen No. 137.

Identities of the specimens were confirmed by A. W. Cameron. Special thanks are due to G. W. Malaher for expediting collecting in a restricted area. This is contribution No. 716, Forest Biology Division, Department of Forestry, Ottawa, Canada.—Charles H. Buckner, *Forest Biology Laboratory, Box 6300, Winnipeg 1, Manitoba. Received 23 January 1961.*

A SUMMER COLONY OF MALE LITTLE BROWN BATS

It has long been recognized by students of the North American vespertilionids (Christian, Am. Midl. Nat., 55: 66–95, 1956; Dalquest, Am. Midl. Nat., 38: 224–247, 1947; Griffin, J. Mamm., 21: 181–187, 1940; Pearson *et al.*, J. Mamm., 33: 273–320, 1952; Wimsatt, J. Mamm., 26: 23–33, 1945) that, for the most part, the adult males and females are regularly segregated from one another during the reproductive season. In the spring and summer months females are abundantly available in nursery colonies remaining congregated and away from adult males

during gestation, parturition and post partum care of the young. Such gatherings of adult females may number to the thousands but attendance by adult males is rare; 5 per cent would be exceptional. If one can assume that the adult sex ratio is one to one—actually hibernating populations are predominantly males according to Mohr (Amer. Caver Bull., 14: 3–13, 1952)—then approximately 45 to 50 per cent of the adult summer population is largely unaccounted.

The usual explanation for this discrepancy, since adult males can be obtained at twilight as they forage in the same geographic areas where female nursery colonies are located, is that males roost singly or in small groups in isolated hiding places, rather than migrating to other areas in summer. Our observations show that males do utilize such hard-to-find sites as cracks and crevices in rocks, spaces in hollow trees and small openings behind sidings, roof shingles or loose bark, and that these males seldom occupy such a space for more than a night or two. Presumably these roosting sites provide for a reasonable share of the male population but we have long thought that there must be large gatherings as well in order to account for male populations that at least equal in number those of the female.

Winter cave explorations in western Pennsylvania and central West Virginia by individuals from this laboratory and by various members of the Pittsburgh Grotto National Speleological Society have disclosed the usual bisexual nature of the winter bat populations hibernating in the caves of these areas. It is usual to find that most bats desert the caves in spring and do not return until late fall.

In July and August 1959, members of the Pittsburgh Grotto entered Hellhole Cave (see W. E. Davies, Geol. and Econ. Surv. W. Va., 19, 1958), Pendelton County, West Virginia, in search of bats. This cave, a vertical pit in excess of 180 feet, is accessible only by rope or flexible ladder. On each occasion a sample of approximately 100 bats (*Myotis lucifugus*) was selected at random from large clusters hanging on the tunnel walls. These bats, all adult males, constituted less than an estimated 20 per cent of the total population. The cave was again visited in June 1960 and 40 bats were selected at random from the hundred or more roosting on the cave walls; again all were males. This cave has long been known to be a favored roosting site for bats and in places their guano has accumulated to a depth of several feet indicating that their tenure has long included the nonhibernating seasons. This colony, to my knowledge, is the first large summer aggregate of male *Myotis lucifugus*.

This work was supported by a grant (RG 6599) from the National Institutes of Health.—PHILIP H. KRUTZSCH, *Dept. of Anatomy, Univ. of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania.* *Received 3 March 1961.*

YELLOW BAT COLLECTED OVER SOUTH ATLANTIC

On 16 March 1960, at 1745 Local Zone Time (2045 Greenwich Civil Time), a male yellow bat, *Dasypterus ega*, flew on board the icebreaker, U.S.S. "Glacier," at Lat. 41° 04.5′ S, Long. 56° 21.5′ W. This position is off the coast of Argentina, about 335 km (approximately 208 miles) SE of a point of land lying between the towns of Quequén and Miramar in the Province of Buenos Aires. The bat was captured by a member of the crew, and given to Robert Cushman Murphy to whom we are greatly indebted for this interesting specimen (A.M.N.H. No. 185261; field No. R.C.M. 5021).

Dr. Murphy reports that the U.S.S. "Glacier" was in passage from the Falkland Islands to Buenos Aires. A moderate to fresh northerly breeze (Beaufort scale, force 4 to 5) had been blowing all day; in fact, the direction and force of the wind had been constant since early on 15 March when the ship left the Falklands. The ocean was covered with whitecaps; the air temperature was 63°F, and the surface water temperature 56°F. The sky was heavily overcast throughout this period.

The interest in this record lies not alone in the taking of this specimen far out at sea, but also in the season of year, late summer, a fact which to me suggests that the bat may have been migrating northward. Several capes, below latitude 40° S in Argentina, could provide points

of departure for overwater flights of yellow bats migrating along the coast. The strong northerly winds reported on the above dates could have blown this particular bat off course to the eastward. The optimum course for this and other migrating bats would lie much closer to the coast. However, if this individual had maintained a northward flight line from the point where he came on board the U.S.S. "Glacier" he would eventually have reached land in the vicinity of Cape San Antonio, north of the city of Mar del Plata. Even if he had kept "drifting" to the east, because of the necessity of "quartering the wind" to make forward progress, he could have made a landfall on the coast of Uruguay or southern Brazil.

We know little of the life history of *Dasypterus ega*, particularly of the southern South American populations. Reference to migratory flight is speculative. It is also possible that the yellow bat of Argentina is non-migratory, and that this bat was blown out to sea by a seasonal storm. We do, however, have many records of migration over the ocean in the middle latitudes of the northern hemisphere by members of the very closely allied genus, *Lasiurus*. Handley (Proc. U. S. Nat. Mus., 112: 459–479, 1960) regards *Lasiurus* and *Dasypterus* as congeneric.

Lasiurus borealis is frequently recorded at various distances off the eastern coast of North America during both the fall and spring migration periods. *Lasiurus cinereus*, *Lasiurus borealis* and *Lasionycteris noctivagans* are now regularly reported from the Bermudas, almost 600 miles offshore. Van Gelder and Wingate (Am. Mus. Novitates 2029: 1–9, 1961) recorded a fourth species, *Lasiurus seminolus*, from Bermuda, and discussed the status of bats in this group of islands. It seems logical to assume that bats reaching the Bermudas are stragglers that have been blown or "drifted" off the American coast during migration. *Lasiurus* has even reached the Galápagos and Hawaiian Islands.

Dr. Murphy preserved this bat by deep-freezing it on board ship, and kept it frozen upon reaching home. The bat appears to have been in good physical condition. There are large deposits of fat along the flanks under the skin. External measurements, taken upon receipt of the specimen at the Museum on 23 August 1960, are as follows: total length 122, tail vertebrae 58, hind foot (with claw) 9.5, ear (from notch) 12, forearm 47.2, wingspan 357 mm. The skull was removed and cleaned; the skin and body were preserved in alcohol. Selected cranial measurements are: greatest length, 16.1, zygomatic breadth 11.6, interorbital breadth 5.1, braincase breadth 8.7, braincase depth 6.5, maxillary toothrow 6.0, postpalatal length 7.0, palatal breadth 7.6. Methods of taking cranial measurements of bats follow Handley (Proc. U. S. Nat. Mus., 110: 95–246, 1959.—HOBART M. VAN DEUSEN, *Archbold Expeditions, Dept. of Mammalogy, American Museum of Natural History, New York City.* *Received 21 April 1961.*

NEW GUINEA RECORD OF THE TUBE-NOSED INSECTIVOROUS BAT, *MURINA*

During August 1959 the Sixth Archbold Expedition collected for 16 days in the vicinity of the Collins Brothers' sawmill on the south slopes of Mt. Otto, Bismarck Range, in the Eastern Highlands District of the Territory of New Guinea. The sawmill is near the village of Kotuni, about 11 miles by road north of the town and airport of Goroka. On 12 August a young native boy brought the author a small bat which he had caught in a hole in the ceiling of one of the mill's bunkhouses. The bat was at once recognized as belonging to the genus *Murina* (Family Vespertilionidae) by reason of the placement of its nostrils at the tips of short tube-like extensions of the nose. The noses of *Nyctimene* and *Paranyctimene* (Suborder Megachiroptera) are somewhat similarly modified. To my knowledge, this is the first recorded occurrence of *Murina* on the mainland of New Guinea.

Murina has a wide distribution in eastern and southern Asia, including the islands of Sakhalin, Japan, Taiwan, Hainan and Ceylon. It has also been found in the Philippine Islands, Sumatra, Borneo and Java. However, there are relatively few records for the genus east of Wallace's Line, and the following remarks will be confined to the 14 known specimens from this area. *Murina* has not been recorded from Australia.

The British Museum has a specimen (B.M. No. 63.12.26.14) collected by A. R. Wallace on the island of Flores, which Oldfield Thomas (Ann. Mag. Nat. Hist., Ser. 8, 2: 371–372, 1908) described as *Murina florium*. A second specimen of *Murina* (skin with skull inside) collected by Wallace on Flores is at the Zoologisches Museum der Humboldt-Universität in Berlin (K. Zimmermann, *in litt.*, 3 August 1961). Thomas (*op. cit.*: Ser. 8, 5: 534–535, 1910) next described as *Murina lanosa* a specimen (B.M. No. 10.3.4.24, ♀) collected by W. Stalker in 1909 on the island of Ceram. Thomas also noted that the British Museum had a second specimen (B.M. No. 7.1.1.482) from Ceram, probably collected by A. R. Wallace.

Historically, the first specimens of *Murina* known to have been collected east of Wallace's Line were taken by Dr. E. A. Forsten, a member of the "Natural History Commission for the Netherlands Indies," on the island of Ceram during the latter part of 1842. Skull "a" (incomplete, sex unknown) of Jentink's *Catalogue Ostéologique des Mammifères* (Mus. d'Hist. Nat. Pays-Bas, Leide, 9: 280, 1887) was listed as *Harpiocephalus suillus*, and is in the collection of the Rijksmuseum van Natuurlijke Historie at Leiden. Skin "a" (mounted skin with skull inside, ♂) of Jentink's *Catalogue Systématique des Mammifères* (*op. cit.*: 12: 185, 1888) was identified as *H. suillus*, and is also at the Rijksmuseum. Father A. M. Husson (*in litt.*, 24 May 1961) wrote, "some years ago . . . I examined the specimens of Forsten, mentioned by Jentink in his Catalogues as *H. suillus*, and I came to the conclusion that both the skin as well as the skull belong to *Murina lanosa* Thomas." Laurie and Hill (List of Land Mammals of New Guinea, Celebes and Adjacent Islands, 1758–1952, Brit. Mus. [Nat. Hist.], 1954) ascribed a Goram Island specimen (B.M. No. 10.3.4.115) collected by W. Stalker to *Murina lanosa*.

A collection of mammals from Manus Island and Ruk Island (also spelled Rooke; also called Umboi) in the Bismarck Archipelago was reported on by Thomas (*op. cit.*: Ser. 8, 13: 434–439, 1914). A single *Murina*, collected by A. S. Meek and Eichhorn on Ruk Island, is listed, but without being specifically determined. Thomas commented that this specimen (B.M. No. 14.4.1.33, ♀) was "allied to *M. lanosa* of Ceram." A few years later Thomas (*op. cit.*: Ser. 9, 11: 254, 1923) described *Murina toxopei* from a specimen (B.M. No. 23.1.2.27, ♀) collected by L. J. Toxopeus in 1921 at En-Biloro on the island of Buru. Thomas believed this new species to be "nearly allied to *M. florium*." J. Edwards Hill of the British Museum has kindly examined the specimen from Ruk Island, and has compared it with the types of *M. lanosa* and *M. toxopei* (corrected spelling, *toxopeusi*) and one other specimen of *M. lanosa*. Hill (*in litt.*, 14 Feb. 1961) remarked, "on the balance of characters, the Ruk specimen is very close to *toxopeusi* (undescribed at the time of Thomas' 1914 note) and perhaps should be referred to this form;" but Hill also warned, "the available material is so limited that *lanosa* and *toxopeusi* cannot be separated with certainty since the small differences may well be individual." R. Mertens (Zool. Jahrb., Jena, 68: 304–305, 1936) recorded two specimens (Nos. 129 ♂, 130 ♀) collected by Erie in 1927 at Dompoe on the island of Sumbawa as *Murina suilla*. No. 130 (SMF 12 395), skin and skull, is in the collection of the Senckenbergische Naturforschende Gesellschaft at Frankfort a. M. Laurie and Hill (*op. cit.*: 1954) considered the Sumbawa specimens as "most probably *Murina florium florium*." In addition to the above records the Archbold Collections contain two specimens (A.M.N.H. Nos. 109110 ♂, 109111 ♀) collected on Peleng Island, off the east-central coast of Celebes, by J. J. Menden in 1938. G. H. H. Tate (Bull. Am. Mus. Nat. Hist. 78: 578, 1941) wrote that these specimens "conform closely to the description of *Murina florium*." Laurie and Hill (*op. cit.*: 1954) reduced *M. lanosa* and *M. toxopeusi* to subspecies of *Murina florium*.

In summary, three of the eight island populations represented by the above specimens have been given specific rank. However, more recent evaluation of the characters on which these species were founded would seem to indicate that only one good species is present east of Wallace's Line. The number of populations deserving recognition as subspecies is difficult to predict because of the lack of specimens, and because direct comparison of the available material has not been possible. I do not think it is advisable to identify the New Guinea specimen to a lower taxon until a direct comparison is made with the typical material in the British Museum.

The Mt. Otto specimen of *Murina* (A.M.N.H. No. 192251, ♀) is the first example of the genus to be taken in the course of six Archbold Expeditions to New Guinea. The sawmill camp was at an elevation of about 2200 meters in a clearing in the narrow valley of the Iamahagi, a beautiful stream draining the south slopes of Mt. Otto. Most of the original forest had been destroyed below the sawmill, and had been replaced by garden patches, grass and forest regrowths. Near the mill there were only remnants of the former montane mixed rain forest along the Iamahagi and of the once luxurious forest on the middle slopes. The only cave we discovered in this area was examined carefully; *Murina* was not found. Members of the expedition regularly shot bats at dusk, after nightfall (with the aid of spotlights), and occasionally at dawn throughout the course of the trip.

I do not believe that this small bat is as rare as the experience of various field collectors would indicate. Practically nothing is known of the life histories of the members of this genus. *Murina* very probably has peculiar roosting or flight habits (or both) that make its discovery by routine collecting methods accidental. Capt. T. Hutton (Proc. Zool. Soc. London, 711–712, 1872), the collector of *Murina huttoni* at Jeripanee in the northwestern Himalayas (elevation about 1700 meters), commented on an individual that entered a house during the night: "instead of soaring round the room towards the ceiling, as bats generally do, it kept low down, passing under the tables and chairs .... This likewise is the mode of flight when searching for insects in the open fields, where it skims closely and somewhat leisurely over the surface of the crops and grass." Hutton found this species to be uncommon at the above locality. H. E. Anthony (Field Mus. Nat. Hist., Zool. Ser., 27: 83, 1941) wrote of *Murina cyclotis*: "this is a rare species in museum collections and we found it to be so in the field. The single specimen secured was shot at dusk while flying near the resthouse at Gangfang [Burma, 1600 meters]." J. K. Jones, Jr. (J. Mamm., 41: 265, 1960) described the discovery in Korea of three *Murina* in the stomach of a snake (*Elaphe schrencki*); this oriental racer readily climbs trees. Jones commented, "the snake was taken along a small stream at the base of a wooded hill that supported numerous granite outcroppings. Either trees or outcroppings may have afforded a place of retreat for the bats." The elevation was 200 meters. F. N. Chasen (Bull. Raffles Mus., Singapore, 15: 55, 1940) wrote, "the tube-nosed bats are all rare, or difficult to collect, in Malaysia."

External measurements, taken in the field on the day of collection, are as follows: total length 89; tail vertebrae 39; hind foot (with claw) 9; ear (from notch) 12.5; forearm 35; wingspan 260 mm. The skull has been removed and cleaned; the skin and body are preserved in alcohol. Selected cranial measurements are: greatest length 15.4; zygomatic breadth 8.9; interorbital breadth 4.3; braincase breadth 7.8; braincase depth 6.2; maxillary toothrow 5.3; post-palatal length 4.9; palatal breadth 5.3. Methods of taking cranial measurements of bats follow those of Handley (Proc. U. S. Nat. Mus., 110: 95–246, 1959). The recorded weight, taken in the field on a small postal scales, is 0.15 ounce (4.25 grams). Ectoparasites were collected from this specimen but no identifications have been received to date.—HOBART M. VAN DEUSEN, *Archbold Expeditions, Dept. of Mammalogy, American Museum of Natural History, New York City.* *Received 12 May 1961.*

AGE AT SEXUAL MATURITY OF MEXICAN FREE-TAILED BATS

This paper reports reproductive data that suggest the age at sexual maturity of the Mexican free-tailed bat, *Tadarida brasiliensis mexicana*. These data were collected as a portion of a general ecological study which emphasized the reproduction, behavior, movements and population dynamics of the bat in Texas. This general study was supervised by Richard B. Davis and directed by David E. Davis, of the Division of Vertebrate Ecology, The Johns Hopkins University. It was supported by grant E1040 from the National Institutes of Health.

Weekly field trips were made to Davis Blowout Cave, 25 miles north of Fredricksburg, Blanco Co., Texas, during the period from 9 April through 20 October 1958. Samples totaling 500 flying male bats were collected and subsequently autopsied to determine their sexual condi-

tion and several thousands of bats were examined for the presence of bands. These bats were obtained with the aid of a portable variation of the "bat harp-trap" designed by Constantine (J. Wildl. Mgt., 22: 17–22, 1958). Bats autopsied for this study were killed by suffocation in a portable dry ice box. All autopsies were performed in the laboratory where the wet weights of the testis and the prostate were made on a 500-mg Roller-Smith Balance. The presence or absence of sperm was diagnosed from the microscopic examination of testis smears.

The periodic recapture of marked animals of known age can furnish conclusive evidence of the age at which animals become sexually mature. Only seven of the 1,100 female bats, banded in 1957 shortly after they became flying fledglings, were recovered in the spring months of 1958; but all seven were pregnant. These recaptures proved that at least some female bats are sexually mature in their first spring. This conclusion agrees with that of Glass (J. Mamm., 40: 542–545, 1959) and also that of Sherman (J. Mamm., 18: 176–187, 1937), who worked with the southeastern free-tailed bat, *T. b. cynocephala*. None of the 1,100 young male bats banded in 1957 was recovered in 1958; so the determination of the age of sexual maturity from this method was not possible.

A useful suggestion of the age when young male bats become sexually mature can be made from a comparison of the weights of the testis and the prostate gland which increase and decrease at particular times of the year. During the 7-month interval between April and October 1958, adult males were not found at Davis Cave in the 8-week period from 13 July through 14 September. Bats born in 1958 were first observed in the flying population on 13 July. The testis and prostate weights from the autopsied bats are organized into frequency distribution charts by monthly intervals in Tables 1 and 2 to emphasize variations in weight and those instances when sperm were found are listed in these tables.

In the autumn, testis weights greater than 26 mg were obtained from adult bats compared to testis weights less than 24 mg collected during the spring months. In the autumn the prostate weights for adult bats were at a 3–7-mg resting stage, but prostate weights in April were greater than 40 mg. All of the 31 instances in which sperm were found during the course of

TABLE 1.—*Frequency distribution of testis weights (mg) expressed as number of animals per testis weight class*

Testis weight class	April	May	June	July	August	1–14 Sept.	15–30 Sept.	October
26.0 plus								3
24.0–25.9								3
22.0–23.9	4(4)*						2	6
20.0–21.9	2(2)*						3	7(1)†
18.0–19.9	6(6)*						9	3
16.0–17.9	6(5)*						8	5
14.0–15.9	10(7)*		1				6	2(1)†
12.0–13.9	6(5)*	5	3				3(1)†	—
10.0–11.9	19(2)*	14	8	3			—	(1)†
8.0– 9.9	14	28	18	10			—	—
6.0– 7.9	20	27	27	3		(1)†	1	(1)†
4.0– 5.9	7	18	9	—	(1)†	(3)†	(8)†	(6)†
2.0– 3.9	1	2	1	(25)†	(39)†	(37)†	(23)†	(22)†
Totals	95	94	67	41	40	41	63	59

500

* Animals within this group having sperm.
† Animals within this group probably born in 1958.

this study occurred in April, and then only in those animals whose testes and prostates were each greater than 10 mg. Clearly those months when the bat is absent from the caves in central Texas are critical in the reproduction of the species. Sherman (*op. cit.*) lists testis and prostrate data for *T. b. cynocephala*, in Florida, for all the months of the year. His data indicate that the testis weights of adult bats are low between May and August, but that a proliferation of testicular tissue occurs in September which results in a steady increase in testis weight. A peak weight of nearly 70 mg was observed in February, and a rapid decrease in this measurement occurred in March and April. Sherman found that sperm were present only from January through April. His linear measurement of the prostate gland showed a 250 per cent increase in February and March over the values recorded for the rest of the year. The data given in Tables 1 and 2 appear to follow closely the trends in Sherman's data.

During the spring months all male bats examined had a red-brown pelage, and their teeth were either sharp or worn. At this time it seemed that two classes of male bats were examined. One class (sharp and worn teeth and red-brown fur) was found to be sexually mature. During April these animals had both large testes and large prostate glands (each averaging more than 10 mg) with or without sperm being evident. The second group (sharp teeth and red-brown fur) appeared in April as sexually immature animals with testes and prostate glands which were both significantly smaller (each averaging less than 7 mg). A decrease in weight of both the testis and the prostate, during the summer months, was observed for both groups of animals. These lower weights were maintained at least until 13 July, when adult males were no longer present in the summer population.

During the autumn of 1958, animals born in 1958 (subadults with sharp teeth and gray pelage) consistently had a testis weight to 6 mg and a prostate weight to 3 mg. Bats born prior to 1958 (adults with both worn and sharp teeth but with red-brown fur) at this time had a prostate weight greater than 3 mg and a testis weight greater than 12 mg. During this season

TABLE 2.—*Frequency distribution of prostate weights (mg) expressed as number of animals per prostate gland weight class*

Prostate weight classes	April	May	June	July	August	1–14 Sept.	15–30 Sept.	October
40 plus	12(6)*	1						
30 –39	4(2)*	—						
20 –29	10	—	1					
10.0–19	14	15	1					
9.0– 9.9	3	4	—					
8.0– 8.9	3	14	2					
7.0– 7.9	1	11	4	1			2	
6.0– 6.9	6	14	13	5			3	5
5.0– 5.9	1	7	13	2			11	8
4.0– 4.9	6	11	11	7			12(1)†	9(1)†
3.0– 3.9	3	11	7	1			3	6(1)†
2.0– 2.9	2	5	12	(13)†	(11)†	(16)†	11(10)†	8(7)†
1.0– 1.9	—	—	—	(12)†	(28)†	(25)†	(21)†	(23)†
0 – 0.9	—	—	—	—	(1)†	—	—	—
Totals	65	93	64	41	40	41	63	59

466

* Animals within this group having sperm.
† Animals within this group probably born in 1958.

there was no evidence of the existence of two sexual classes among the adult males. Presumably subadult animals born in June 1958, with a significantly smaller testis weight in their first autumn, are sexually immature in the following spring. During their second summer, when about 14 or 15 months old, these sexually immature males (sharp teeth but now red-brown fur) undergo increased testicular activity so that in their second autumn they are similar to other adult bats on the basis of testis and prostate weights. From January through April, then, it is possible that these animals about 18 to 22 months of age would be observed as sexually mature animals with sharp teeth and red-brown fur.—HENRY L. SHORT, *Dept. of Fisheries and Wildlife, Michigan State Univ., East Lansing.* *Received 16 March 1961.*

A COLLECTION OF BATS FROM SINALOA, WITH REMARKS ON THE LIMITS OF THE NEOTROPICAL REGION IN NORTHWESTERN MEXICO

Several years ago, Luther Little of Littlerock, California, very kindly loaned me the Neotropical bats from his private collection of bats of the world. Included were a number of specimens from Sinaloa collected by Chester Lamb in the years 1934–1935. The collection appears to be of exceptional interest in view of the generally transitional nature of the fauna of northwestern Mexico, lying near the boundary between the Nearctic and Neotropical regions. The specimens are discussed below by species. All localities are in southern Sinaloa in the general vicinity of Rosario, except for El Molino, which is farther north, fairly near Culiacan. Altitudes are given only when over 100 ft. Measurements given are in millimeters.

Balantiopteryx plicata.—Two males collected at Rosario, 4 October 1934. These appear to be intergrades between *B. p. plicata* of southern Mexico and *B. p. pallida* of northwestern Mexico, inasmuch as the skulls are large as in *plicata*, but the pelage light as in *pallida*.

Noctilio leporinus mexicanus.—A single male collected at Chele (400 ft altitude), 16 February 1935, appears referable to this subspecies, having a forearm length of 47, greatest length of skull 28, condylobasal length 25.1, and maxillary toothrow length 10.9. The color is bright rufous, the mid-dorsal line indistinct. This represents a considerable northward extension in range, inasmuch as the genus *Noctilio* apparently has not previously been reported farther to the northwest than Papayo, Guerrero, the type locality or *N. l. mexicanus*.

Glossophaga soricina leachii.—One male and one female collected at Rosario, 4 October 1934; two females from 8 mi southeast of Rosario, 22 April 1935; two males and five females collected at El Molino, 18–27 May 1934.

Artibeus cinereus aztecus.—One male and three females from Rancho Batel (5200 ft altitude), 5 mi northeast of Santa Lucia, 22 November 1934. The forearm length ranges from 42 to 44, greatest length of skull 21.6–22.3, condylobasal length 19.6–20.2, maxillary toothrow 7.2–7.3. These records represent a considerable northward range extension in the Sierra Madre Occidental from the previously reported localities in Morelos and Guerrero. While I agree with Davis (1958) that *aztecus* and *toltecus* are forms quite distinct from *cinereus* and from one another, I am inclined to concur with Dalquest (1953) that both *aztecus* and *toltecus* are best considered subspecies of *Artibeus cinereus*, at least until sympatry is demonstrated. The three forms, *A. c. phaeotis*, *A. c. toltecus*, and *A. c. aztecus*, in Mexico appear to be restricted to the southeastern portion, the cooler or dryer lowlands to the north and west, and to the mountain rim of the Mexican plateau respectively. The species has previously been recorded from Sinaloa by J. A. Allen (1906: 237) under the name *Dermanura phaeotis* and from Durango by Andersen (1908: 300). In each case, there is some doubt as to the subspecies, though since the Sinaloa locality (Esquinapa) is at less than 500 ft in elevation, *A. c. toltecus* is probably the subspecies involved.

Artibeus turpis nanus.—One male and one female collected at Cacolotan, 25 March 1935. I follow Davis (1958) in considering *nanus* a subspecies of *A. turpis*.

Natalus stramineus.—Seven males and ten females collected at Rosario, 4 October and 4 December 1934. If the subspecies *saturatus* is really distinct from *mexicanus*, this probably

TABLE 1.—*Distribution of bats in northwestern Mexico by states*

Species	Sinaloa	Durango	Chihuahua	Sonora	Baja Calif.
Balantiopteryx plicata	+			+	+
Noctilio leporinus	+				
Chilonycteris parnellii	Hooper, 1955	+	+	+	
Pteronotus davyi	+			Constantine, 1959	
Glossophaga soricina	+	+	Anderson, 1960	+	
Anoura geoffroyi		Baker, 1960			
Sturnira lilium			Anderson, 1960		
Chiroderma sp.			Anderson, 1960		
Artibeus jamaicensis	Anderson, 1960				
Artibeus hirsutus	Anderson, 1960		Anderson, 1960		
Artibeus cinereus	+	+			
Artibeus turpis	+				
Desmodus rotundus			Anderson, 1960	+	
Natalus stramineus	+	+	+	Constantine, 1959	+
Rhogeesa parvula	+			+	
Molossus sinaloae	+				

represents an intergrade population. Color variation is extreme, ranging from near Kaiser Brown of Ridgway through Cinnamon Brown to near Buckthorn Brown. I concur with Goodwin (1959) in considering *mexicanus* and *saturatus* to be subspecies of *Natalus stramineus*.

Rhogeesa parvula parvula.—One male and four females collected at El Molino, 18–21 May 1934. These appear to be the first records from the state of Sinaloa, though this form is known from both Sonora to the north and Nayarit to the south (Goodwin, 1958).

Sixteen species of bats with an essentially Neotropical distribution, but not reaching the United States, have now been recorded from the five states of western Mexico lying chiefly north of the Tropic of Cancer. The distribution of these 16 species is given in Table 1. References are given only for those records not mentioned either above or in Hall and Kelson (1959).

It may be noted that six species, which reach Sinaloa or Durango, do not reach Sonora or Chihuahua. These all appear, on the basis of present records, to be confined to the southern portions of these states, none reaching farther than 25°N. Of the remaining ten species, all but two reach their northern limits in southern Sonora or southwestern Chihuahua, not extending much above 28°N. The two exceptions are *Pteronotus davyi* and *Natalus stramineus*, which reach north to central Sonora. Thus there appear to be two natural limits to the Neotropical bat fauna in northwestern Mexico, one going acress south-central Sinaloa, the other across south-central Sonora. The first of these lines is quite close to the northern edge of the Nearctic-Neotropical Transition Zone as drawn by Hershkovitz (1958: 587), the second considerably farther north. It will be interesting to see whether other groups of Neotropical mammals show similar distributional breaks and, if so, what the ecological significance of these limits may be. —KARL F. KOOPMAN.

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ADDITIONAL RECORDS OF BATS IN NEW MEXICO

The Mexican big-eared bat, *Plecotus phyllotis*, is known to occur in San Luis Potosi, at Miquihuana, Tamaulipas, in the Chiricahua Mountains, Cochise Co., Arizona (Handley, Proc. U. S. Nat. Mus., 110: 95–246, 1959), and 28 miles south and 9 miles east of Flagstaff, Coconino Co., Arizona (Findley and Jones, J. Mamm., 42: 97, 1961). On 15 June 1960, a pregnant female of this species containing one fetus 24 mm in crown–rump length was captured at an approximate elevation of 7,000 ft, 2 miles northeast of Wall Lake, Black Range, Catron Co., New Mexico. The animal was taken in a mist net stretched across an earthen tank in a canyon. Vegetation in the immediate area consists of *Juniperus monosperma*, *Quercus gambelii*, *Pinus edulis* and scattered *Pinus ponderosa*. On 19 July 1960, two lactating females were taken at the same locality. Other bats taken at this station were *Lasiurus cinereus*, *Lasionycteris noctivagans*, *Eptesicus fuscus*, *Myotis thysanodes* and *Antrozous pallidus*.

On 20 June 1960, two male *P. phyllotis* were taken in a mist net over a rearing pond at the State Fish Hatchery, Glenwood, Catron Co., New Mexico, at an approximate elevation of 5,800 ft. No mature sperm was disclosed by a microscopic examination of smears from the testes and epididymides of these specimens. The vegetation in the vicinity of the hatchery consists of *J. monosperma*, *Quercus grisea*, *Platanus wrighti*, *Populus* sp. and *Salix* sp. Taken at this station on the same date were *L. cinereus*, *L. noctivagans*, *A. pallidus* and *Tadarida brasiliensis*.

On 22 June 1960, a lactating female Mexican big-eared bat was taken at an approximate elevation of 7,500 ft at Willow Creek, 10 miles east of Mogollon, Catron Co., New Mexico. Vegetation in the area consists of *Pseudotsuga taxifolia*, *Picea engelmanni*, *Populus tremuloides*, *Q. gambelii*, *P. ponderosa* and *Salix* sp. On 25 July 1960, another lactating female was taken at this locality. Collected at this same station were *Myotis volans*, *M. occultus*, *L. cinereus*, *L. noctivagans*, *E. fuscus* and *T. brasiliensis*.

On 23 June 1960, five lactating females were captured at an approximate elevation of 7,800 ft, 9 miles east of Mogollon, Catron Co., New Mexico. The animals were taken in a mist net stretched across an earthen tank in a meadow surrounded by *P. ponderosa*. On 24 July 1960, two lactating females were taken at this same station. On 26 July 1960, a lactating female was shot by E. D. Fleharty at the same locality. Taken at this same station were *L. cinereus*, *L. noctivagans*, *E. fuscus* and *Euderma maculatum*. Most of these bats were taken between 8:05 and 10:10 PM, while temperatures ranged between 10 and 17°C.

The flight of *P. phyllotis* is characterized by slow wing beats, and the animals are relatively slow flyers. Flight seems to be in a straightline, not in the erratic pattern followed by some of

the smaller forms. The vocal utterances of *P. phyllotis* consist of a series of rather loud "peeps." The intensity and frequency of the "peeps" seem to fluctuate; the frequency increases as the animal approaches the watering area.

External measurements of 15 specimens of *P. phyllotis* are: total length 114.0 mm (109–119); tail 47.7 (45–51); hind foot 8.4 (7–9.5); ear from notch 37.2 (36–40); length of forearm 47.1 (45.3–48.9); weight 12.5 g (10.4–17.4). Cranial measurements, taken as described by Handley (*op. cit.*: 98–99) are: greatest length of skull 17.0 mm (16.6–17.3); zygomatic breadth 9.3 (9.1–9.6); interorbital breadth 4.2 (4.0–4.3); maxillary toothrow 5.5 (5.4–5.7); postpalatal length 6.5 (6.2–6.6); breadth of braincase 9.8 (9.6–10.0); depth of braincase 5.5 (5.3–5.6); palatal breadth 6.2 (6.1–6.4).

The spotted bat, *Euderma maculatum*, is known to occur in New Mexico at Mesilla Park, Dona Ana Co. (Miller, Proc. Biol. Soc. Wash., 16: 165–166, 1903), at Ghost Ranch, Rio Arriba Co. (Constantine, SW Nat., 6: 92–97, 1961), and from 2 miles north of Aztec, San Juan Co. (Rodeck, J. Mamm, 42: 401, 1961). On 23 June 1960, I captured three lactating females and two males of this species 9 miles east of Mogollon, Catron Co., New Mexico. The animals were taken in a mist net stretched across a tank in a meadow in a yellow pine forest, from 9:10 to 9:25 PM, while the temperature was 11°C. No mature sperm was noted in the testes or epididymides of the males.

The voice of *E. maculatum* is similar to that of *P. phyllotis*. However, to my ear, the "peeps" of the spotted bat seem to be slightly higher pitched than those of the Mexican big-eared bat.

External measurements of the five specimens are: total length 124 mm (119–130); tail 50.8 (47–55); hind foot 10.0 (10.0–10.0); ear from notch 41.6 (41–42); length of forearm 51.0 (48.6–52.6); weight 16.5 g (13.6–18.4). Cranial measurements are: greatest length of skull 18.9 mm (18.6–19.2); zygomatic breadth 10.3 (10.0–10.6); interorbital breadth 4.2 (4.0–4.5); maxillary toothrow 5.8 (5.6–5.9); postpalatal length 7.7 (7.5–8.0); breadth of braincase 10.1 (9.9–10.3); depth of braincase 5.8 (5.7–5.9); palatal breadth 6.8 (6.6–7.0).

The red bat, *Lasiurus borealis*, is known to occur at Carlsbad Cavern, Eddy Co., New Mexico, and at Rattlesnake Spring, 5 miles south-southwest of Carlsbad Cavern, Eddy Co., New Mexico (Constantine, J. Mamm., 42: 404, 1961). On 15 May 1960, a pregnant female of this species, containing two 10 mm embryos, was captured at the State Fish Hatchery, Glenwood, Catron Co., New Mexico. On 13 June 1960, two lactating females were taken at this locality. These three were taken between 8:25 and 9:47 PM with temperatures from 13 to 19°C. On 21 June 1960, another lactating female was captured at this station at 5:30 AM in the mouth of a dead *Rana catesbeiana*. Seemingly the frog leaped to capture the trapped bat and, itself, became tangled in the net.

Comparison of specimens of *L. b. borealis* from Kansas and Ohio with the above specimens reveals that the latter specimens have skulls markedly smaller in size, darker and redder fur, smaller ears, and external basal ear lobes that are reduced in size and without a prominent anteriorly directed process. These features are said to characterize *L. b. teliotis* (Miller, N. Am. Fauna 13: 110–111, 1897). Our knowledge at present suggests that a hiatus between *L. b. borealis* and *L. b. teliotis* exists in central New Mexico.

External measurements of the four animals are: total length 110.5 mm (108–112); tail 46.5 (46–48); hind foot 8.0 (7–11); ear from notch 9.8 (9–10); length of forearm 40.8 (40.0–42.5); weight 10.9 g (7.6–13.5). Cranial measurements are: greatest length of skull 12.0 mm (11.9–12.1); zygomatic breadth 9.1 (9.0–9.2); interorbital breadth 4.2 (4.1–4.2); maxillary toothrow 4.2 (4.1–4.2); postpalatal length 5.5 (5.4–5.6); breadth of braincase 7.6 (7.5–7.6); depth of braincase 5.5 (5.4–5.5); palatal breadth 5.8 (5.7–5.8).

Of the aforementioned specimens, one female *E. maculatum* is preserved in the University of Arizona Department of Zoology; the others are preserved in the University of New Mexico Collection of Vertebrates. Field work resulting in the capture of these animals was financed by the National Science Foundation.—CLYDE J. JONES, *Dept. of Biology, Univ. of New Mexico, Albuquerque.* *Received 3 January 1961.*

SHARP-SHINNED HAWK PREYS ON RED BAT

Saunders (J. Mamm., 11: 225, 1930) has recorded one of the dangers, destruction by lighthouses, faced by the three Ontario species of migratory bats: the red bat, *Lasiurus borealis*, the hoary bat, *Lasiurus cinereus*, and the silver-haired bat, *Lasionycteris noctivagans*. Recent activities of bird banders at Point Pelee on Lake Erie, Ontario, show they are also subject to destruction by a diurnal predator, the sharp-shinned hawk, *Accipiter striatus*.

Point Pelee is well known to ornithologists as a concentration area for many species of birds as they funnel down from the north and along the shores of the lower Great Lakes. Apparently our migratory bats follow much the same route. At least they are killed occasionally at the Long Point Lighthouse on Lake Erie, and toward the western extremity of the lake red bats and silver-haired bats are regularly observed in some numbers at the tip of Point Pelee during the fall migration.

A particularly heavy flight of sharp-shinned hawks occurred in the Point Pelee area on 17 and 18 September 1960. The first day was noticeable for the complete lack of small birds, but during the night substantial numbers of passerines moved into the area. In the early morning they were observed moving about the low bushes at the end of the Point and, mingling with the small birds, were a considerable number of red bats and silver-haired bats.

Commencing at dawn on 18 September, an extensive feeding movement by the hawks began. They could be seen in all directions pursuing their prey. This feeding activity continued until about 10 AM, but reached its peak during the first hour and a half of the daylight hours. During this latter period ten birds and one red bat, all dead, were deposited in a series of mist-nets by captured hawks. Also during this early morning period, nine red bats and one silver-haired bat were taken in the nets and released. The sharpshin carrying the red bat was taken at 7:15 AM, approximately one hour after sunrise. All bat movement ceased about 1½ hours after dawn, no further bats being taken in the nets, nor were any more observed in flight after this time.

When the red bat victim was being prepared as a study skin at the Museum, it was found that a single claw of the hawk had pierced the body from the back, severing one rib and causing extensive hemorrhages in the thoracic cavity. The only other injury that could be found was a single claw perforation on one wing. The hawks were observed to strike and hold on to small birds in flight. The lack of any sign of mauling suggests the bat, perhaps, had been taken in the same way, by a single clutch of the hawk's talon.

At present we do not have enough data to determine how extensively the hawks were feeding on the bats. Under these circumstances, however, in which migratory movements produced a heavy concentration of both bats and hawks and the bats remained active during the peak of the hawk-feeding period in the early dawn, predation could have been quite high.

Hitchcock (The Ring, 2: 278, 1960), in a summary of bat-banding in America, comments that nearly all the bats banded are colonial species. Members of the Ontario Bird Banders' Association have offered to band the bats they take, in considerable numbers for the migratory species, at Point Pelee each fall.—S. C. DOWNING, *Dept. of Mammals*, AND D. H. BALDWIN, *Dept. of Birds, Royal Ontario Museum, Toronto. Received 13 February 1961.*

VOLE PREDATION ON BATS IN AN INDIANA CAVE

On 18 March 1961, the author visited a southern Indiana cave known locally as Ray's Cave. This cave is 5 miles east of Bloomfield, Greene County, in the NW ¼, Sec. 13, T. 7 N, R. 4 W. During a search for dead bat remains which might have bands, the complete skeleton of a prairie vole, *Microtus ochrogaster*, was found with much of its fur still intact on a narrow limestone shelf several feet above the floor. As the skeleton was found 783 feet from the nearest known entrance, and as the cave runs horizontally into a limestone cliff, this might by itself be considered unusual. However, surrounded both above and below by the vole's fur were a dentary, two complete scapulae, and several phalanx fragments of a bat, *Myotis* sp. Several

phalanges were found in the neck region of the vole, but the absence of fur in this region does not permit more than a guess that they were in the throat. On a second shelf immediately below the first were several terminal phalanges. All the remains were in a readily visible position; none were present on 4 February 1961, when an earlier trip was made to this cave. Both upper incisors and the lower left incisor of the vole were broken off at the point of emergence from their alveoli, the broken ends not being evident in the area. The evidence seems to indicate that the vole died with part of the bat's wing stuck in its throat. As no other bat bones were present within 100 feet, the vole may have traveled for some distance in this condition. There is other evidence of predation on bats by voles in this cave. Approximately 123 feet inside the main entrance, a crevice in the wall yielded the remains of 23 persimmon seeds (*Diospyros virginiana*), three acorns (*Quercus* sp.) and two bats (*Myotis* sp.). While phalanges were scattered at random, crushed pieces of bat skull were found mixed with small pieces of acorn. Tracks are abundant in the dirt on wall ledges in the passage as far as about 200 feet from the main entrance, and dirt has been excavated from openings in the limestone wall. In front of two such excavations the phalanges of at least five bats were found scattered, though no other bones were found. These may have been moribund or dead bats which were being utilized as food by the voles, since they were found in the front part of the cave to which the hibernating bats move in the spring, and from which weakened bats may fall when fluctuating or extreme cold spring temperatures occur.

Further back in the cave, about 1000 feet from the entrance, were the fresh remains of a *Pipistrellus subflavus*, the skin being turned inside out in a manner familiar to all who see what mice do to their victims. The few skeletal remains had many interspersed fresh mice feces present. As the pipistrelles were hanging low on the walls, and this was not in the front part of the cave, I am convinced that this was a case of true predation on a living bat.—Robert L. Martin, *Dept. of Zoology, Univ. of Illinois, Urbana.* *Received 28 March 1961.*

A WHITE COTTONTAIL RABBIT

The only record of a white rabbit is by E. W. Nelson (N. Am. Fauna 29, p. 26, 1909) in his section on melanism and albinism, both of which he says are extremely rare among American rabbits. He had seen two albinistic individuals, one of *Sylvilagus floridanus mallurus* and one of *S. transitionalis*.

A white cottontail rabbit, *Sylvilagus floridanus mearnsi*, was shot by the writer on 4 December 1959, on the 4-H Memorial camp in the Robert Allerton Park, 5 miles south and 2½ miles west of Monticello, Illinois. A 100-acre study area, where continuous rabbit research (Illinois PR W-42-R) has been conducted since 1956, is located on the 4-H area. Several rabbits on the area were subjected to X rays during the winters of 1957 and 1958, which may possibly have resulted in a mutation.

The female rabbit was a juvenile, as shown by the open humeral epiphyses and the weight of the lens (100 mg), the latter indicating an age of 3 months. The measurements were as follows: weight 680 g, total length 395 mm, tail length 76, tarsus 79, and ear 47. The eyes were the normal dark brown color. The normally slate, brown, and gray hairs were white and the rufous nape was merely dull buff at the base. Some of the longer guard hairs were black-tipped. To an observer a few feet away, it was essentially a white rabbit.

The rabbit is specimen No. 21789 at the University of Illinois Natural History Museum, Urbana.—David A. Casteel, *Illinois Natural History Survey, Urbana.* *Received 2 February 1961.*

ACTIVITY RHYTHM OF THE PLAINS POCKET GOPHER

Remarks on the activity periods of pocket gophers are scattered through the mammalian literature, but this phase of the behavior of these rodents remains poorly known. Tryon (Mont. St. Coll. Agr. Exp. Sta., Tech. Bull. 448, 1947) opened burrow systems of the mountain pocket

gopher, *Thomomys talpoides*, in Montana at intervals throughout the 24-hour period and recorded the times at which openings were plugged. He concluded that the mountain pocket gopher has two major peaks of activity, one in the late afternoon and one immediately after dawn. Grinnell and Storer (ANIMAL LIFE IN THE YOSEMITE, 1924, p. 136) observed that pocket gophers in California, *T. bottae* and *T. monticola*, are most active about sundown and in the early morning, but that gophers may be active at any time of the day. Most workers have agreed in general with the above authors. In contrast, we found that daily activity of the plains pocket gopher, *Geomys bursarius*, in the laboratory was evenly distributed throughout the day and consisted of numerous active periods alternating with slightly longer inactive periods.

Continuous records of activity for three adult *Geomys*, two females and one male, were taken for a two-week period. The animals were trapped 4 miles north of Hudson, Weld County, Colorado, and were housed separately in wire cages at Fort Collins, Colorado. Each cage contained a small wooden nest box into which the gophers retreated to rest. A trip-wire was fastened across the entrance of each nest box. A deflection of the wire in any direction closed an electrical circuit, thus activating a 1.5-volt motor and moving a pen on a revolving drum. Simultaneous recordings were made for the three gophers on a tape moving at a constant rate of 36 cm each 24 hours. Records of active animals consisted of many vertical pen strokes close together, making short inactive periods difficult to detect. To facilitate the reading of the tape, the records were divided into quarter-hour intervals, and activity during each interval was recorded as plus or minus. The animals differed in their reactions to the trip-wires. During activity periods we observed that animals almost invariably left their next boxes, ate, and moved restlessly around their cages. A gopher could not leave or enter its nest box without tripping the recorder. Thus, although the numbers of vertical pen marks on the tape per activity period varied widely between animals, the spacing and duration of the activity periods were probably accurately recorded. The temperature in the laboratory fluctuated little, averaging about 65°F. The gophers were under normal conditions of daylight and darkness (averaging approximately 13 hours and 50 minutes of daylight per 24-hour period).

The daily activity rhythm of *Geomys* in the laboratory consisted of a series of short activity periods alternating with somewhat longer resting periods. Seemingly, light or darkness had no effect on activity, for differences in activity between daylight and darkness were not detected, and there were no clear activity "peaks" (Fig. 1). Generally, the activity periods were roughly

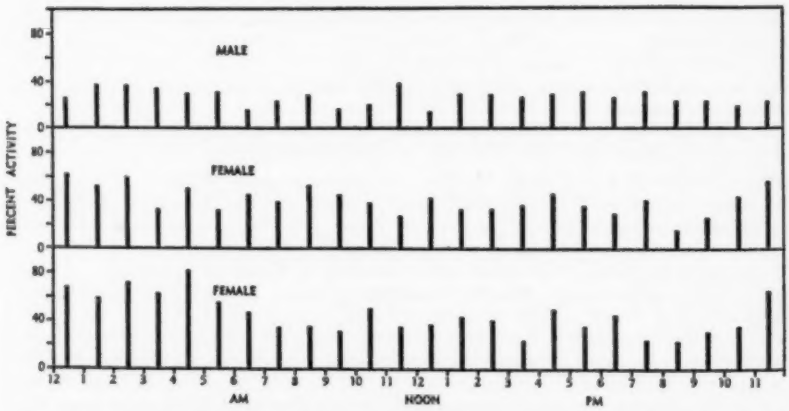

FIG. 1.—Per cent activity for each hour of the day of three *Geomys* under laboratory conditions. Figure based on two weeks of recorded activity.

TABLE 1.—*Summary of two weeks' activity of three* Geomys bursarius *under laboratory conditions*

Type of measurement	No. 1, ♀	No. 2, ♀	No. 3, ♂
Mean number of active periods per day	16.7	13.8	17.8
Per cent of time animal was active	47.3	28.8	25.9
Mean length of active period, hr	.68	.50	.35
Mean length of inactive period, hr	.76	1.24	1.00

equal in length, and were separated by resting periods similar to each other in length. Occasionally animals had unusually long active or resting periods, but these were scattered randomly through the records and suggested no trend toward heightened activity at certain times of the day. The gophers studied averaged 16.1 activity periods per day, and were active 34 per cent of the time. The average activity period was .60 hours in length, and the average resting period, 1.0 hour.

The diel cycle of each animal was different (Table 1). Although the male had the highest frequency of activity, he was active the least amount of time. The average number of daily activity periods per animal did not differ widely between animals, but there was considerable variation in the active and inactive periods and the average total amount of activity per day between animals. This variation seemed to reflect individual differences in behavior, for each animal's record was fairly consistent throughout the recording period.

Our experience in trapping *Geomys*, *Thomomys* and *Cratogeomys* tends to support the laboratory observations. In the course of trapping several thousand pocket gophers, the impression was gained that the animals may be active at any time of the day. Chances for a capture increase with the total length of time the traps are set; setting traps a certain times of the day seems not to increase captures.

Miller (Proc. Zool. Soc. Lond., 125: 505–519, 1955) described activity in small mammals as consisting of a feeding rhythm and a diel cycle controlled by light and temperature. Except when gophers come to the surface of the ground to feed or to push soil to the surface, they live under conditions of constant darkness and relatively constant temperatures. It is probable that the fossorial mode of life resulted in the absence of a diel cycle governed by light and temperature, and that the activity cycles observed are governed primarily by the high metabolic demands of gophers. The major effect of temperature is probably to cause seasonal changes in the metabolic rates of the animals and thus cause the frequency and perhaps duration of the activity periods to change. The peaks in digging activity at dawn and dusk, observed by many workers, may represent the times when gophers are most active in pushing soil to the surface of the ground, but not necessarily when gophers are most active. Between the peaks of surface activity there are probably other activity periods when the gophers are less inclined to repair damaged tunnels. The peaks in surface activity may be governed by light and perhaps temperature, whereas the diel activity rhythm is probably largely dependent on metabolic demands. —TERRY A. VAUGHAN AND RICHARD M. HANSEN, *Experiment Station, Colorado State Univ., Fort Collins.* *Received 20 April 1961.*

[Technical Journal Article S. S. 713, Colorado Agricultural Experiment Station.]

THE HARVEST MOUSE IN NORTHERN VIRGINIA

When Mearns (Am. Nat., 31: 160, 1897) reported a specimen of *Reithrodontomys humulis* that he had caught at Fort Myer, Arlington County, Virginia, on 6 December 1896, he supposed that it was the northernmost record for the species and the first record for the state of Virginia. However, Audubon and Bachman (QUADRUPEDS OF NORTH AMERICA, 2: 105, 1851) had already reported that "A specimen was sent to us by our friend Mr. Ruffin, who obtained it in Virginia."

Subsequently, specimens from Falls Church, Fairfax County (1897), and from Alexandria, Virginia (1902), were listed by E. T. Hooper (Occ. Pap. Mus. Zool., Univ. Mich., 477: 19, 1943). The only other northern Virginia specimen known to us is one in the Patuxent Research Refuge collection, taken by Jack Spencer near Winchester, Frederick County, Virginia, in 1941. *Reithrodontomys humulis* has been taken once north of the Potomac River, near Takoma Park, Maryland (Hooper, *loc. cit.*).

It appears that this mouse is uncommon at the northeastern extremity of its range. We were thus pleased when we trapped five additional northern Virginia specimens in our High School science project. Two were caught in separate fallow fields on a farm 3.4 miles east of Fairfax, Virginia, on 3 January and 16 August 1960, and two others were trapped in another fallow field 2.4 miles east of Fairfax on 18 January and 29 February 1960. The fifth specimen, caught in a deserted field 5.5 miles northwest of Chantilly, on 31 August 1960, is the first harvest mouse to be recorded from Loudoun County.

Because of their large size and grayish coloration, Charles O. Handley, Jr., has identified these specimens as *Reithrodontomys humulis virginianus* Howell. We have presented the specimens to the National Museum.—RICHARD AND DANIEL PEACOCK, *200 Highland Rd., Fairfax, Virginia.* *Received 27 February 1961.*

THE PORCUPINE AND FISHER IN ALABAMA ARCHAEOLOGICAL SITES

The 1933–1939 archaeological surveys of the Pickwick, Wheeler and Guntersville basins of the Tennessee River were sponsored jointly by the Alabama Museum of Natural History and the Tennessee Valley Authority. Among the many vertebrate skeletal fragments recovered during the excavations were those of two species, the porcupine, *Erethizon dorsatum*, and the fisher, *Martes pennanti*, whose present-day ranges lie considerably farther to the north.

The fisher fragment, consisting of a portion of the maxillary bone with several posterior molars attached, was recovered from the Law's Site, Ms°100 in Marshall County, northeastern Alabama. This village site is located about 2,000 feet north of the southern end of Pine Island in the Tennessee River. Although the site had long been under cultivation by white man, the excavation revealed at least three distinct aboriginal horizons (Webb and Wilder, An Archaeological Survey of Guntersville Basin on the Tennessee River in Northern Alabama; Univ. Ky. Press, 1951) which included a prepottery complex (ca. 1000 B.C.) separated from the two layers above by a deep layer of sterile sand. No vertebrate remains were examined from the prepottery horizon. The sand layer was overlain by an extensive village of a limestone-tempered pottery culture (Gunterlands, III, ca. 900 A.D.) upon which had been superimposed a later village using shell-tempered pottery (Gunterlands, IV, ca. 1200 A.D.) which continued to the time of white contact (Gunterlands, V, ca. 1700 A.D.). The vertebrate fauna from this and 22 other sites in Colbert, Jackson, Madison and Marshall counties is to be discussed in a later paper.

The fisher maxillary bone fragment (FS609) was associated with Burial No. 41, a historic interment probably around 1700 A.D. (Wm. S. Webb, personal communication). A number of brass arm and wrist bands as well as several iron bar bracelets and a glass mirror accompanied this contact burial. The occurrence of the fisher as a burial association is, of course, inconclusive evidence of its former presence in Alabama; however, Audubon and Bachman (Quadrupeds, 1: 314, 1854) reported seeing a specimen which was taken near Asheville, Buncombe County, North Carolina, and they also examined several skins from "East Tennessee." They mention hearing of a specimen "captured near Flat-Rock, in that State, latitude 35°." The "Flat-Rock" to which Audubon and Bachman referred is believed to have been located at or near the present town of Hohenwald in Lewis County, Tennessee, at Latitude 35° 7′. The locality in "East Tennessee" was not designated; however, there is a "Black Fox" in Bradley County. The origin of the name for this location is not clear, but the fisher is known as the

"black fox" throughout much of its range. The southern distribution of the fisher, as indicated by Audubon and Bachman, would have placed this animal well within the reach of hunting parties from Ms°100. While the occurrence of this species in Alabama is still open to question, it is quite possible that a few individuals may have reached the northeastern part of this state. Parmalee's report (J. Mamm., 41: 409–410, 1961) of the recovery of a right mandible of the fisher from the Etowah Site, Bartow County, in northwestern Georgia, suggests the probability of the former occurrence of this species in both Georgia and Alabama. The Etowah Site was thought to have been occupied from about 1100 to 1500 A.D. If the fisher did occur in northern Alabama and Georgia, it undoubtedly occurred also in the mountainous parts of South Carolina, although there appear to be no known historical or archeo-zoological records from South Carolina.

Porcupine, *Erethizon dorsatum*, remains were found in three collections from the Little Bear Creek Site, Ct°8, Colbert County, in northwestern Alabama. Ct°8 is a shell mound of Archaic age as defined by Webb and DeJarnette (The Flint River Site, Ma°48; Mus. Paper 23, Ala. Mus. Nat. Hist., 1948). Occupancy of Ct°8 began in Archaic I, ca. 3000 B.C. and continued through Archaic III, ca. 1000 B.C. A second people, having a Koger's Island Complex culture, used the mound as a burial site ca. 1540 A.D.

The porcupine remains in each case consisted only of the left ramus of the lower jaw. The Archaic I cultural level contained one specimen and the other two fragments were from collections of Archaic II age (ca. 2000 B.C.). None of the rami was associated with human burials. The presence of three individuals, each from a different collection, is strong circumstantial evidence of the occurrence of this species in Alabama during the Archaic. It seems unlikely that the porcupine occurred in Alabama during the Gunterlands III and later periods, for evidence of its presence would almost certainly have been found in the collections from the 22 sites containing Gunterlands III and later cultures. Lewis and Kneberg (Hiwassee Island; Univ. Tenn. Press, 1946) did not report the presence of *Erethizon* in the Hiwassee Island site which was occupied from Gunterlands IV into the Gunterlands V period. All recent records on the occurrence of species in the eastern United States are north of Latitude 38°. Gilmore (J. Mamm., 28: 227–234, 1946) commented on its absence from three archaelogical sites in southwestern Pennsylvania which are temporally comparable to those of the Gunterlands IV period in Alabama. Kellogg (Proc. U. S. Nat. Mus., 86: 245–303, 1939) reported a left mandible from an immature porcupine in the National Museum with the notation that it came from a "Tennessee cave." While the mandible could have come from a porcupine which lived within the past century, the archaeological evidence indicates that the species has not lived in Tennessee for many centuries. Mercer (Proc. Am. Phil. Soc., 36: 36–70, 1897) found porcupine remains in Big Bone Cave, Van Buren County, Tennessee, which were contemporaneous with the fossil sloth, *Megalonyx*, and also porcupine quills and droppings of a more recent period. The *Megalonyx* material appeared to be so recent that Mercer hypothesized that giant sloths witnessed the coming of the Indian hunter to Tennessee. The strata in the cave had been so disturbed by burrowing rodents and by man that he was unable to positively establish the contemporaneity of the aborigines and *Megalonyx* in the site.

Mercer's work indicates that the porcupine was a resident of the Big Bone Cave area probably as late as the Archaic period. The Hiwassee Island site mentioned above is approximately 40 miles airline from Big Bone Cave. The finding of the three porcupine jaws in the Little Bear Creek Site, Ct°8, suggests that the range of the species in the early Archaic period may have extended into northern Alabama. The absence of the species from all Alabama collections of Gunterlands III and later is interpreted to mean that, following the Archaic and prior to the Gunterlands III period, there was a recession northward of the porcupine's range. This recession appears to have occurred many centuries ago. Gilmore (J. Mamm., 28: 146–165, 1947) hypothesized a progressive southern extinction of the porcupine in Coahuila, Mexico, based upon archaeologic faunal remains in cave sites.—FREDERICK S. BARKALOW, JR., *Dept. of Zoology, North Carolina State College, Raleigh.* *Received 30 March 1961.*

WOLVERINE IN IOWA

On 21 May 1960, a wolverine, *Gulo luscus luscus*, was shot on the Ted Mitchell place in Sec. 3, T. 68 N, R. 15 W, Tama County, Iowa. A motorist, who first saw the animal as it crossed a county road and entered the Mitchell farm, immediately notified the farm owner at his nearby home. Pursuit of the strange animal was immediate.

One man drove a pickup after the fleeing animal while the second man stood in the box of the truck and fired a shotgun at the strange creature. Chances for escape were small because the fields had been newly planted to corn and therefore were without cover. After several shots the animal was dispatched. Conservation Officer William Boswell brought it to Iowa State University for autopsy. The specimen, an adult wolverine, was certainly a stranger to Iowa, and a long way south of the currently known range for this species.

Literature indicates wolverines were once fairly common in northern Minnesota, and one specimen was killed in LaCrosse County, Wisconsin, in 1870 (Cory, 1912). Lyon (1936) reports two records of wolverines in Indiana, one in the northeastern part and one in the southwestern part of the state. Goding (1883) in his catalogue of the mammals of Iowa lists the wolverine as extremely rare. Osborne (1890) in his list of specimens of mammals of Iowa did not include the wolverine, but in his publication of 1891 he included it, apparently on authority of Goding. There is no record of a wolverine being taken in Iowa previous to the one here reported for 1960.

With the kill of a wolverine having been made in LaCrosse County, Wisconsin, which is only 20 miles north of the Iowa-Minnesota boundary, there is reason to believe that an occasional individual may have wandered into northeastern Iowa in presettlement times. The timbered Mississippi River bottoms and adjacent oak-covered upland woodlands of southwestern Wisconsin, southeastern Minnesota, and northeastern Iowa should have provided the animal a reasonably suitable habitat into which to wander on occasion.

How the female wolverine killed in Iowa in 1960 got here is a mystery. I doubt that it got here on its own power or as a captive animal. Parts of three of its feet were missing, and its teeth were well worn indicating that at some time in the past it had a successful battle against a multiple set of traps. The trap incident apparently occurred after the permanent teeth came in, hence during maturity. Although its feet were well healed, the animal was missing four toes from the right and two from the left hind foot, and three toes from the left front foot. The remaining foot was intact. These circumstances indicate the specimen probably had not been a zoo animal or pet. It is doubtful that a lone specimen, under current conditions, would wander into Iowa several hundred miles south of its known present-day range far to the north. It is my opinion that the lone individual accidentally came south in an enclosed semi-truck or van of some sort.

The specimen was an adult female weighing 22.0 lbs. Measurements taken by the author were: total length 876, tail 229, hind foot 168, and ear (notch to tip) 49 mm. All the epiphyseal plates were completely ossified, and the incisors showed much wear.

The female was not pregnant and showed no signs of recent pregnancy. The uterine horns when inflated were relatively even-diametered except for two slight whitish bulges on one horn. Whether or not these had any connection with a previous pregnancy is unknown. There were no signs of any corpora lutea or follicular development in the ovaries. When inflated with preserving fluid, the uterus was found to have a total capacity of 7 cc. Since it was not pregnant, it may have been isolated from contact with any adult male since before the previous mating season. Wolverines breed in the summer and experience a delayed implantation (Wright and Rausch, 1955). Young are usually born in March or April (Wright and Rausch, 1955, and Krott, 1959).

Food items taken from the wolverine's stomach included hair, skin, and chunks of internal organs of either cow or goat (95% by volume). This food was probably taken as carrion, for it included carrion-type beetles. On the basis of availability, the carrion most likely consisted of cow or calf remains. The remaining 5 per cent of the food items included egg shells of pheas-

ants and other ground-nesting birds. Traces of feathers and two caudal vertebrae of an unknown small mammal were also present.

Ascarid worms (23), all females of the genus *Physaloptera* were found, with many free in the mesenteries and on the surface of the viscera. The ascarids probably escaped from the intestines after shotgun pellets punctured these organs. The lungs, heart, liver, kidney and spleen were free of worms.

A sample of muscle tissue was found harboring *Trichinella spiralis*, the cause of trichinosis. It was negative for western viral encephalitis.

Three dog ticks, *Dermacentor variabilis*, were recovered from the carcass. Careful washing and combing of the pelt failed to reveal other ectoparasites. Storage as a frozen specimen for about a week may have caused ectoparasites to leave the carcass.

The skin is in possession of William Boswell, Conservation Officer, Reinbeck, Iowa. The remaining pieces of the skull and the skeletal bones (Autopsy No. 605) are at Iowa State University, Ames, Iowa.

Assistance in determining various facts for the specimen is acknowledged as follows: species determination—Richard H. Manville, Fish and Wildlife Service; food habits and endoparasites —Patuxent Research Center; ticks by Wilfred S. Craig, and trichinosis by William J. Zimmerman, both of Iowa State University. Results of the test for encephalitis were made available by R. P. Hanson of the Department of Veterinary Science, University of Wisconsin. The assistance of Conservation Officer William Boswell, who brought the specimen to Iowa State University, is appreciated.

This report is a contribution of the Iowa Cooperative Wildlife Research Unit, jointly sponsored by Iowa State University of Science and Technology, the Iowa State Conservation Commission, the Bureau of Sport Fisheries and Wildlife, and the Wildlife Management Institute.—
Arnold O. Haugen.

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Dept. of Entomology and Wildlife, Iowa State Univ., Ames. Received 1 March 1961.

A PLEISTOCENE RECORD OF *ZALOPHUS* FROM MEXICO

The only previously recorded genus of otariid from the Pleistocene of the Pacific Coast of North America is *Eumetopias* (Kellogg, Bull. Dept. Geol. Univ. Calif., 13: 23–132, 1922). In spite of this at least four otariid genera (including *Eumetopias*) have inhabited the western shores of North America in Recent times. It would appear in consideration of the widespread and well-established distribution of some of these genera that they might well have arrived on these shores at least as early as the Pleistocene.

The genus *Zalophus* is distributed at present from the western coast of Mexico in the Gulf of California (Chiasson, J. Mamm., 35: 596, 1954) to the coast of Oregon and southern Washing-

ton and rarely even as far north as British Columbia (Kenyon and Scheffer, U. S. Fish and Wildlife Serv., Circ. 32, 1955). The genus is represented by a single North American species, *Zalophus californianus*. *Zalophus* is also known from the Pleistocene of New Zealand and the Upper Pliocene of Australia (Kellogg, *op. cit.*).

The present report describes a Pleistocene example of *Zalophus* from Tiburon Island, Sonora, Mexico. William Smith, of the Department of Anthropology, University of Arizona, acquired a fossilized phalanx of an adult otarid from Luis Moreno, a Seri Indian from Tiburon Island. This fossil was presented to the author by Mr. Smith in 1958 and is now specimen No. LACM 4333 in the Vertebrate Paleontology collection of the Los Angeles County Museum. Smith has determined that this specimen was found on the northern half of Tiburon Island by the Indians.

Very little is known of the geology of Tiburon Island, although a brief study has been made of its southern margin (Anderson, Geol. Soc. Am., Mem. 43, 1950). This study indicates that uplifted marine terraces containing Pleistocene fossils are common "along the east coast line of Lower California and the islands, including Tiburon." McGee and Johnson (Nat. Geogr. Mag., 7: 125–133, 1896) have reported Pleistocene sediments in Sonora east of Tiburon Island. Anderson (*op. cit.*) further points out that no pre-Pleistocene fossils are to be found in Tiburon and Sonora.

Since the specimen under consideration was discovered on Tiburon Island I have assumed its age to be Pleistocene. The fossil has been compared with phalanges of both male and female manus and pes of the three living West Coast genera of otarids. This comparison indicates that the specimen is from an adult male *Zalophus*.

The fossil agrees in all details with the proximal phalanx of the first digit of the right foot of an adult male *Zalophus* (Plate I). The next closest comparison was with the middle phalanx of the right hind foot of a female *Eumetopias* (LACM 551). Although the lengths of the two

FOSSIL MODERN FOSSIL MODERN

PLATE I

Phalanges of a fossil and a modern adult male *Zalophus*. Dorsal views at left, ventral at right; distal ends at top.

bones are virtually the same (fossil, 10.6 cm; *Eumetopias*, 10.5 cm) the fossil is broader (fossil greatest breadth, 2.9 cm; *Eumetopias* greatest breadth, 2.4 cm) than the Recent specimen. My conclusion is therefore that the fossil is the proximal phalanx of the first digit of the right foot of an adult male *Zalophus* of Pleistocene age. This animal was probably of the same species (*Z. californianus*) as the living California sea lion.

I wish to thank Theodore Downs and the Los Angeles County Museum (LACM) for their generous loan of specimens.—ROBERT B. CHIASSON, *Dept. of Zoology, Univ. of Arizona, Tucson.* *Received 26 April 1961.*

A PELAGIC IMMATURE NORTHERN FUR SEAL

The article by Radvanyi on a young fur seal captured in the Northwest Territories of Canada (J. Mamm., 41: 277, 1960), reminds me of another pelagic specimen of the northern fur seal, *Callorhinus ursinus*, so far unreported. This was a young individual caught in a net set for albacore-tuna in the northeast Pacific, about 400 miles south of the eastern Aleutians, at 47° 30′ N, 164° 52′ W. It was taken on the night of 29–30 November 1955 by the Pacific Oceanic Fisheries Investigations of the U. S. Fish and Wildlife Service. The specimen was frozen and sent to the same Service at La Jolla, California, where I examined it. The skin, skull and some skeletal parts were preserved and are now at the office of the Marine Mammal Investigations of the same Service at Seattle, Washington.

The specimen was a female of 14 kg. Its measurements were as follows: total length, 865; greatest length to tip of hind flippers, 1090; hind flipper from tip to base of bare plantar surface, 280; fore flipper from axilla, 230; ear to notch, 38, and to crown, 36; length from axilla to tip of tail, 450; girth at axilla, 570 mm. The distance from axilla to tip of tail was barely more than half the distance from tip of nose to tip of tail, indicating the lengh of the neck and showing how far back the fore flippers are placed. These features are significant, hydrodynamically, in efficient and accurate propulsion by the fore flippers, as in the otariids.

The epiphyses of the vertebrae and limbs were open and I presumed the animal to be a young of the year, born from June to August 1955. Radvanyi's specimen, also a young of the year, was taken on 16 October 1958. Both may have been born and departed the Pribilofs early, with more chance of being "off course," as Radvanyi described the situation. If born early, Radvanyi's seal was 4 months old, the one reported here 5 months.

There was little dorsal fat on my specimen, and only 1–2 cm on the belly and chest. I noted the eye as "large" with an evenly curved cornea, where I had expected a flattened cornea. In the pyloric section of the stomach were 21 beaks of squid, some large, and definitely not *Loligo* —such as I have seen in the stomachs of California sea lions, *Zalophus californianus*, and northern elephant seals, *Mirounga angustirostris*, off southern California and Baja California.

The great map of fur-seal distribution by C. H. Townsend (Vol. 3, p. 223–274 *in* D. S. Jordan *et al.*: The fur seals and fur-seal islands of the North Pacific Ocean; Washington, 1899) showed one record, about 300 miles south of the eastern Aleutians, in September, and another in July. Even more interesting was a scattered cluster of records for the central North Pacific, 500 miles or so south of the central Aleutians, in June and July—when the seals should have been on the Pribilofs. Kenyon and Wilke (J. Mamm., 34: 86–98, 1953) remarked that fur seals "are more widely scattered in migration than was formerly recorded."

Radvanyi's record is probably of more significance than the one reported here since it was so far from the usual migration route, or winter range, that it may be considered truly extralimital. Thus it illustrates the non-linear sort of distribution that "springs" an individual, or individuals, into a new and hitherto unoccupied range. I can now visualize a fur seal reaching the North Atlantic via the Canadian Arctic, though establishment there is another matter. It has always interested me that there are no living otariids in the North Atlantic.

It is also notable that these two young fur seals, obviously on their first migration from the pupping ground, were unaccompanied by adults to guide them. I understand from Victor B. Scheffer that the young are never at sea with their mothers. This leaves pure instinct to guide

them away from "home" and back again the next year, unless they later pick up guidance from adults other than their mother.

To my knowledge, no better map of northern fur-seal distribution has appeared since that of Townsend, despite the vastly greater amount of research since his time, especially in the last 30 years. He showed, with colored dots, the occurrence of the fur seals by months, and on a scale amply large. I cannot fail to note that the science of those days, although on a much smaller scale and less instrumentalized than today, was more artistically and communicably presented. —RAYMOND M. GILMORE, *San Diego Museum of Natural History, San Diego, California. Received 30 January 1961.*

ON POST-NATAL MORTALITY IN BARREN-GROUND CARIBOU

It is generally considered that the most critical period of a mammal's life (except for the last day) is the first day or some post-natal period when the newborn mammal is nearly helpless. In the barren-ground caribou, *Rangifer arcticus*, this helpless period is relatively short, amounting to only a few hours. Therefore data on natural mortality during such a period might have significance not only to basic evolutionary and ecological concepts but to techniques of management or utilization of populations.

In early June 1958 I had the opportunity of assessing natural post-natal mortality in caribou at Fawn Lake, Northwest Territories (64° 43′ N, 100° 15′ W). In company with Donald Thomas and Bert Wilk I was camped on the west side of Fawn Lake. We were literally surrounded by caribou in small migrating groups and in maternity bands (Pruitt, Biol. Pap. Univ. Alaska, No. 3, 1960).

A large hill was situated just west of our camp. This hill was utilized by does in a maternity band and in false nursery bands. During the period 6 through 9 June I kept this hillside under fairly constant surveillance for about 8 hours each day or about ⅓ of each diel cycle. At the end of the four days our party inadvertently frightened the caribou away from the hillside. I then systematically searched the hillside for dead fawns. While engaged in the search a supply aircraft arrived on the frozen lake and completion of the search was delayed until the following morning. Because of human and aircraft activity around camp I am quite certain that no caribou used the hillside during the night. The search was completed the following morning. Table 1 presents the observations and calculations from them.

These calculations are based on the premise that births in caribou are equally frequent at any time in the diel cycle. No data on this subject, either contrary or corroborating, seem to be available. There are two main sources of error in the data presented in Table 1. Because a newborn fawn lying curled up on the ground is very hard to see from a distance (especially through a ground drift of smoking snow) I probably missed seeing some. In addition, some of the fawns found dead during the systematic search may have been on the hillside before the period of observation. Both these sources, however, produce errors scaling the mortality figure downwards.

From Table 1 one may conclude, therefore, that about 4.5 per cent (or possibly less) of the fawns born on this particular hillside during the period of observation did not survive.

TABLE 1.—*Summary of caribou post-natal mortality observations*

Date, 1958	Fawns born during 8 hours	Calculated number born in 24 hours	Found dead	Number dead as % of total
6 June	7	21		
7 June	10	30		
8 June	8	24		
9 June	4	12		
Totals	29	87	4	4.5

TABLE 2.—*Weather conditions at Fawn Lake, Northwest Territories, during caribou post-natal mortality observations*

Date	Time	Temp., °F Max.	Min.	Clouds	Wind Direction and Force (Beaufort)		Remarks
6 June	1930	+35	+22	Stratus and strato-cumulus, .9	NW	Strong-gale	Blowing snow
7 June	1000	+30	+21	Low overcast, 1.	NW	Strong–gale	Blowing snow, visibility 50 yd to ½ mile
	2000	+33	+21	Stratus, .9	NW	Fresh–Strong	Blowing snow
8 June	0830	+28	+17	Stratus overcast, 1.	NW	Moderate	
	2000	+44	+24	Stratus overcast, 1.	N	Moderate	
9 June	0900	+55	+20	Stratus overcast, 1.	NW	Gale	Snow and blowing snow, visibility 50 yd to ⅛ mile
	2020	+36	+27	Strato-cumulus overcast, 1.	NE	Strong	Snow turned to fine rain, ceased at 1400

Although crude, this figure is of interest when noted in respect to weather conditions encountered during the time of observation (Table 2). It is clear that near-blizzard conditions prevailed during most of the period of observation.

Fawns captured during this general period were transported by air to Mosquito Lake, Northwest Territories, where they formed the basis for the windchill study reported by Lentz and Hart (Canad. J. Zool., 38 (4): 679–688, 1960).

Apparently no other such calculations have been made of post-natal mortality in North American wild caribou. There is some mention of the phenomenon in the Russian literature on domestic reindeer, *Rangifer tarandus*. I am indebted to Prof. A. N. Formozov of the Institute of Geography, Academy of Science, Moscow, for graciously furnishing me with abstracts of several papers. M. V. Nazarov (Reindeer Husbandry, 1926) observed that in cold springs, if freezing temperatures and winds coincided at the time of fawning, the entire fawn crop was often annihilated. N. Polyakov (Reindeer Husbandry and Cooperation, 1930) observed that a 25 per cent loss of the fawn crop was common.

My calculated mortality figure of 4.5 per cent is of interest when viewed in the light of later observations. On 13 June, at the same locality, a nursery band of 185 animals consisted of 50 per cent does, with 90 per cent of the does followed by fawns. At the same locality on 1 August, out of 837 caribou segregated, 52 per cent were does with 73 per cent of them followed by fawns. Of course, whether these doe-fawn pairs were actually parent and offspring or were foster parent and adopted fawn is not known. Knowing the potential windchill relations (Lentz and Hart, *op. cit.*) of fawns from this population, this mortality datum should serve as a basis for future observations and calculations. It also serves to emphasize the possible physiological differences between domestic reindeer and wild caribou, in addition to the behavioral differences already noted (Pruitt, *op. cit.*).

I am grateful to the Cooperative Caribou Investigation of the Canadian Wildlife Service for the financial support which made these observations possible.—WILLIAM O. PRUITT, JR., *Box 282, College, Alaska.* *Received 10 February 1961.*

ABNORMAL LOWER THIRD MOLAR IN *ODOCOILEUS*

One of the basic dental features of the selenodont artiodactyl is the presence of a posterior third column on the third lower molar. Dik-diks of the subgenus *Madoqua* have lost the third column, and it is greatly reduced in the subgenus *Rhynchotragus*. But, with this exception, it is

normally present in all ruminants (Grasse, Traite de Zoologie, 17: 646, 1955). It is functional in the Cervidae, but reduced in size in the genus *Rangifer*. Colyer (Variations and Diseases of the Teeth of Animals, p. 125, 1936) describes a muntjac (*Muntiacus sinensis*) in which the

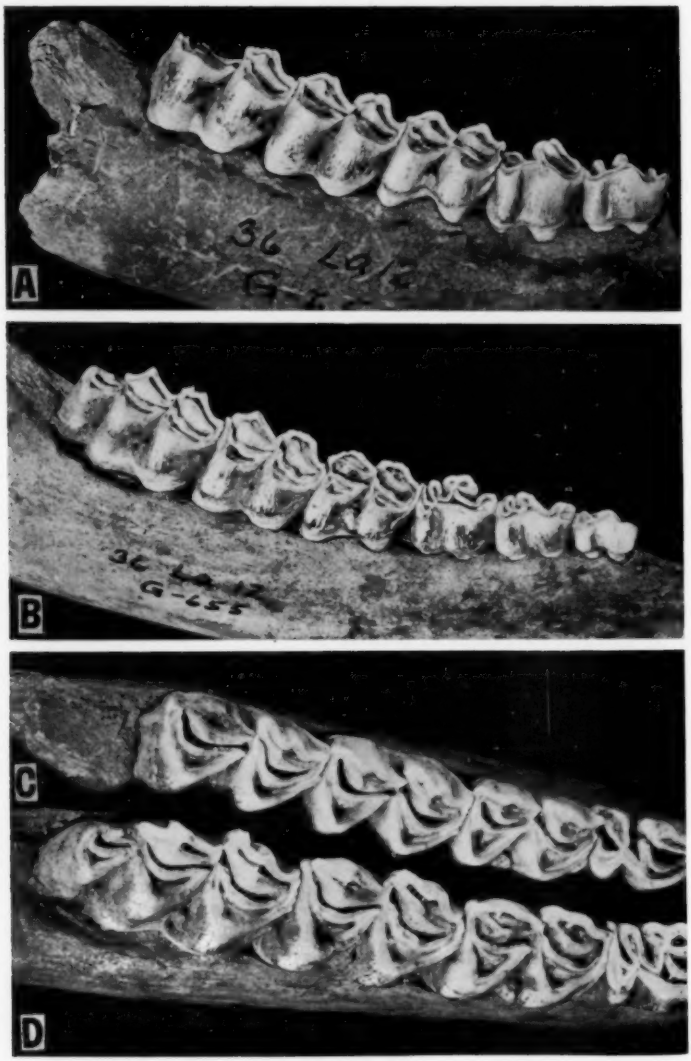

PLATE I

Right mandibles of *Odocoileus virginianus*. *A*, *C*—G-722, with third column on third molar missing; *B*, *D*—G-655, with normal third molar. Photos by W. Galen Barton.

right m_3 was congenitally absent while the left m_3 was smaller and minus the third column. In deer of the genus *Odocoileus* the third column is normally of good size and functional (Plate I, *B, D*).

A right mandible of *Odocoileus virginianus* (G-655, Plate I, *A, C*) with an abnormal third molar, composed of only the two anterior columns, was found in a collection of 297 mandibles (151 left, 146 right) excavated from an early historic, ca. 1600–1625 A.D., Susquehannock Indian village site at Washington Boro, Lancaster County, Pennsylvania (Penna. State Mus. No. 36 La 12). Two other mandibles from the same collection (G-723) had the third column much reduced, its lingual cusp reduced entirely. This collection of at least 151 deer was drawn from the Lancaster County area within a 25-year period, and can be considered part of a single population.

The normal m_3 is double-rooted, but the posterior root is obviously compound. The root of the third column is broadly united throughout its length with the root of the second column. The resulting compound root is more than twice the antero-posterior width of the simple root of the first column. In the abnormal specimen, not only was the third column of the crown missing, the corresponding posterior component of the double root was gone as well. Its course could be traced, however, by a low ridge on the posterior side of the second column root.—JOHN E. GUILDAY, *Carnegie Museum, Pittsburgh, Pennsylvania. Received 17 March 1961.*

AN UNUSUAL CAUSE OF DEATH OF A WHITE-TAILED DEER

Herbert Dill of Mud Lake National Wildlife Refuge, Holt, Marshall County, Minnesota, procured the antlers of a white-tailed deer, *Odocoileus virginianus*, that had become entangled in bog birch (*Betula pumila*) and died. The deer was found dead by Laurence Gutterud on 8 November 1958. Several pieces of the birch were wound around the bases of the antlers and securely knotted. Apparently the deer had been rubbing its antlers to help rid them of velvet. There were strands of velvet intertwined with the birch. The antlers and part of the skull were sent to the Minnesota Museum of Natural History, where they bear the catalog number 4483.—HARVEY L. GUNDERSON, *Univ. of Minnesota, Museum of Natural History, Minneapolis. Received 14 February 1961.*

THE WOOD BISON TYPE SPECIMEN

The wood bison, *Bison b. athabascae*, was described by Samuel N. Rhoads in 1897 (Proc. Acad. Nat. Sci. Phila.: 483–500). He chose as the holotype a bull specimen which was described to him in correspondence by Professor John Macoun of the Geological Survey of Canada. The specimen was reported as an adult bull killed by Indians within 50 miles of Fort Resolution, N.W.T., presumably in March 1892, and presented to the National Museum of Canada by Warburton Pike through the good services of the Hudson's Bay Company (NMC No. 299, accession No. 92–1). "The specimen consists of a well mounted skin with accompanying skull and horn cores separate, all in one iron and glass case," Macoun wrote. The following measurements were provided: height at shoulder 1,703, height at rump 1,602, total length (less tail?) 2,846 mm. The skull was measured by J. F. Whiteaves who reported the frontal width between horn bases as 343, the length of horn core (upper arc) 293, and the horn tip to base (on mounted animal) 229 mm.

The mounted wood bison is still on display in its glass case, but the separate skull lying in front of its forefeet bears the inscription "*Bison americanus*, picked up on prairie, Old Wives Lake, 1887." The same information is repeated on the file card of the type specimen 299. Those data refer to specimen No. 626 of the mammal collection (Old Wives Lake is the present Johnston Lake, Saskatchewan). Either Professor Macoun was in error when he stated the skull of the type specimen was in the case with the mounted animal, or it was exchanged with No. 626

at a later date. The skull of the type specimen has been misplaced since that time. Skinner and Kaisen (Bull. Am. Mus. Nat. Hist., 89 (3): 131–256, 1946) listed the holotype as a mounted specimen and they do not mention examining the skull.

Recent sorting and storing of the large mammal skulls in the museum has brought to light new evidence on the type specimen. A large unnumbered bull bison skull was found, which bore the inked inscription, "skull of W. Pike's wood bison." Upon examining the original accession No. 92-1, it was found that only one bison specimen was donated by W. Pike and it was No. 299. The following measurements were taken according to the standards established by Skinner and Kaisen (*op. cit.*): spread of horn cores, tip to tip 685, greatest spread of cores on outside curve 732, core length on upper curve, tip to burr 272, length of core on lower curve, tip to burr 338, length tip of core to upper base at burr 222, transverse diameter of core 91, vertical diameter of core 106, circumference of core at base 305, width of cranium between cores and orbits 287, greatest postorbital width 345, width of skull at masseteric processes at M^1 197, greatest width at auditory openings 261, width of condyles 123, occipital crest to tip of nasals 455, occipital crest to tip of nasal-frontal suture 256, depth, occipital crest to lower border foramen magnum 150, basilar length of skull 518, over-all length of skull 568, alveolar length of maxillary toothrow 149, M^1–M^3 alveolar length 93, median length of premaxilla beyond P^2 150, rostral width at maxillary-premaxillary suture 113, and the following additional measurements: length of mandible 435, height of mandible 228, mandibular toothrow alveolar length 155 mm.

A comparison of the above measurements with Skinner and Kaisen's (*op. cit.*: 164) table of measurements for *B. b. athabascae* showed that the present skull is generally larger than average for the subspecies with the sole exception of basilar length. The frontal width between horn bases now measures 332, as compared to 343 reported by Whiteaves in 1897. However, there seems to be no reason to doubt that the present specimen is the skull of the holotype and it has been so designated.

Another large bison skull was found at the same time, which bore the inscription "wood bison, nr. Lying-Wood Mt., Fort Smith, Athabasca District 1898." It also carried the old Paleontological Museum No. 7397. Through that number it has been identified as No. 625 (accession No. 98–8) of the mammal collection donated by Col. F. White, Commissioner of the Royal North West Mounted Police. It is probably the specimen 625 studied by Skinner and Kaisen.

Banfield and Novakowski (Nat. Mus. Can., Nat.-Hist. Paper 8, 1960), reporting upon the survival of wood bison in Wood Buffalo Park, erroneously stated that the type specimen of *Bison bison athabascae* was secured by Warburton Pike in 1890. Unfortunately, Soper (Ecol. Monogr., 11: 145, 1941) introduced the error into the scientific record and in following him, we repeated it. In Warburton Pike's account of his 1890 buffalo hunt (The barren ground of northern Canada. Macmillan, London, 1892; p. 356), it is clearly stated that he killed only a cow bison which seemingly was not preserved as a specimen. However, we may assume that he left instructions with the Hudson's Bay Company at Fort Resolution to secure a bull specimen from Indian hunters for him. Such a specimen was finally secured in 1892 and served as Rhoads' type.—A. W. F. Banfield, *National Museum of Canada, Ottawa, Ontario. Received 26 April 1961.*

EFFECTS OF INDUSTRIAL OIL DISPOSAL ON WILD MAMMALS

The effects on wildlife of petroleum products discharged to an environment are often injurious. Waterfowl are frequently trapped with fatal results when they alight on oil-covered water and their feathers become fouled (Phillips and Lincoln, 1930). Few instances of the effects of external contamination by oils have been cited for mammals. A population of muskrats decreased sharply in a marsh in Canada after part of the area was sprayed in 1945 with a solution of DDT in fuel oil and kerosene (Wragg, 1954). The DDT apparently had no effect,

but Wragg (1954) found that a muskrat in a tank of water with 4 cc of fuel oil on the 24 × 44 in. surface exhibited obvious distress by 20 min. After 40 min. only the head was out of water, the body was soaked, and the animal was apparently suffering from exposure, although the temperature of the water in the tank was only 14 to 16°C. Edwards (1952) observed dead small mammals in pools of oil which had accumulated from road resurfacing operations. Other effects of oil on the biota of an area may be less apparent, and the following instance is cited as an example of such an effect on golden mice, *Peromyscus nuttalli*.

A trench pit (15 ft deep × 40 ft × 520 ft) for burning and burying waste materials is located at the disposal area No. 1 near the U. S. Atomic Energy Commission's Y-12 Plant at Oak Ridge, Tennessee. One end of the trench was open, permitting drainage into a small stream. A considerable amount of oil had been dumped into the pit, and a film of oil was on the effluent water. Constant drainage had deposited oil on the ground and vegetation in proximity to the stream. Contamination appeared to have spread considerably during torrential rains when the stream flooded over its banks and when the flow of oil from the pit was accelerated. The contaminated area is a streamside community of scattered black willow (*Salix nigra*) and sweetgum (*Liquidambar styraciflua*), with a dense thicket understory of blackberry (*Rubus* spp.) and Japanese honeysuckle (*Lonicera japonica*).

Twenty-five live-traps were placed in an area bordering the stream on 14 November 1960, and nine golden mice were trapped. Seven of the mice had oily fur and were cold and moribund; the pelage of the other two mice appeared to be normal and the animals were alert and active. The oily hair lay close to the body and in places, especially on the back and hindquarters, the fur had a "plastered down" appearance. The dying individuals could move only feebly, but revived under a heat lamp after about an hour. The traps contained cotton batting for nesting material, and sufficient bait was present to prevent "cold-weather starvation" (Howard, 1951). The low temperature for the night recorded at the Y-12 Plant was 35°F. Even at much lower temperatures mortality of trapped mammals in our studies is rare (excepting shrews), and *P. nuttalli* is one of the species that seems to be least affected by overnight confinement in a trap. Seven white-footed mice (*Peromyscus leucopus*), one cotton rat (*Sigmodon hispidus*), and one pine mouse (*Pitymys pinetorum*) were caught during the same night in areas close by but not in the oil-contaminated zone. None of these animals showed ill effects from trap confinement.

It seems likely that the oily condition of the hair of the golden mice in question caused the fur to become less effective as insulation, and consequently the mice became chilled even though the temperature was above freezing and nesting material was available. It may be that the two mice with normal fur had ranges that did not extend into the oily area. Golden mice may occupy the same shelter nest during the day but range over different areas at night (Dunaway, 1955). A question arises as to how the oily mice survived in the area during the several previous nights when temperatures were below freezing. A possible answer is that several individuals huddled in a shelter nest and their combined body heat and reduced surface-to-volume mass helped them to survive (Pearson, 1947). Several mice living in one nest is common for this species (Goodpaster and Hoffmeister, 1954). However, deaths can occur even among huddling small mammals if temperatures are low enough (Dunaway and Kaye, 1961), and it may be that the mammals of such oil-contaminated areas suffer mortality during periods of cold weather while individuals in uncontaminated areas survive.

Another aspect to be considered is the ingestion of oil by mammals as they eat oil-covered food and as they lick their fur. Lushbaugh and Hackett (1948) found adenomatous lesions in the colons of rats ingesting engine lubricating oil. A residual oil from a catalytic-cracking operation was found to be highly carcinogenic when applied to the skins of albino laboratory mice (Sunderland *et al.*, 1951), and hyperplastic changes in the mucosa of the stomach and colon were found, which the authors speculated may have resulted from ingestion of the oil by mice as they groomed themselves. Chassis lubricant and tractor crankcase oil caused "X-disease" (hyperkeratosis) when administered *per os* to cattle (Sikes *et al.*, 1952).

The Health Physics and Maintenance Planning Departments took immediate action to stop

the escape of the oil from the disposal pit on the Oak Ridge Reservation when the contamination was brought to their attention. Dikes were constructed across the trench. Water in the pits seeps through the permeable weathered shale formation, but the oil remains and is burned. The instance reported in this note emphasizes the need for the biologist to be observant of the environment and to call to the attention of such responsible people as seems necessary those conditions which he recognizes as having harmful effects on wildlife.—PAUL B. DUNAWAY AND STEPHEN V. KAYE.

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REVIEWS

Burroughs, Raymond Darwin, *Ed.* THE NATURAL HISTORY OF THE LEWIS AND CLARK EXPEDITION. Mich. State Univ. Press, East Lansing. Pp. xii + 340. 10 May 1961. Price, $7.50.

The days are past when, as recorded by Meriwether Lewis on 29 April 1805, below the mouth of the Yellowstone River: "Game is still very abundant—we can scarcely cast our eyes in any direction without perceiving deer, Elk, Buffaloe or Antelope. The quantity of wolves appear to increase in the same proportion." (p. 143.) Such accounts today sound almost mythical. It is odd that, of the many volumes devoted to its findings, this is the first to deal extensively with the natural history of the expedition. In the Lewis and Clark journals are the first reliable descriptions of wildlife in the Missouri and Columbia River watersheds. Most of the specimens collected were lost but, from the few that survived, Alexander Wilson named the Lewis' woodpecker and the Clark's nutcracker. George Ord, in 1815, based his descriptions of what we now know as the black-tailed prairie dog, *Cynomys ludovicianus*, the Columbian ground squirrel, *Citellus columbianus*, the bushy-tailed wood rat, *Neotoma cinerea*, the grizzly bear, *Ursus horribilis*, and the pronghorn, *Antilocapra americana*, on others of these specimens. Two years later, without seeing specimens, Constantine Rafinesque described the mountain beaver, *Aplodontia rufa*, the northwestern bobcat, *Lynx rufus fasciatus*, and the mule deer, *Odocoilcus hemionus*, on the basis of material in the Lewis and Clark journals. This source also contained the first detailed descriptions of the white-tailed jack rabbit, *Lepus townsendi*, the chickaree, *Tamiasciurus douglasi*, the eastern wood rat, *Neotoma floridana*, and the kit fox, *Vulpes velox*.

In 1802 our youthful nation, struggling to get firmly on its feet, was concerned over the possibility of Bonaparte's taking possession of Louisiana Territory and occupying the vital port of New Orleans, to our exclusion. By the secret treaty of Ildefonso, France had acquired Louisiana from Spain in 1800. But Bonaparte, fearful of British opposition, had other worries, and negotiations were begun involving our minister to France, Robert R. Livingston, our special envoy to France, James Monroe, and the French foreign minister, Talleyrand. The result was the Louisiana Purchase of 1803 in which the invincible Napoleon sold to the United States, for $15 million, title to vast unexplored lands west of the Mississippi—at about four cents an acre! To consolidate these holdings, President Jefferson in 1804 appointed his private secretary, Meriwether Lewis, and William Clark, youngest brother of General George Rogers Clark, to lead an expedition to explore these newly acquired lands. They were charged with making geographical and ethnological observations along their route, assessing the possibilities of trade, and recording "other objects worthy of notice," including "the animals of the country generally, & especially those not known in the U. S.; the remains and accounts of any which may be deemed rare or extinct." (pp. 292–293.) This expedition, 33 in number, departed St. Charles onto the Missouri River in six large canoes, one bateau or keelboat, and two pirogues on 21 May 1804. At Fort Mandan, North Dakota, where they spent their first winter, two interpreters, plus a French cook and his wife, the Shoshone girl Sacajawea who was so vital to the expedition, joined the party. They crossed the continental divide, pressed on to the mouth of the Columbia River and spent the winter at Fort Clatsop, and returned by approximately the same route, reaching St. Louis on 23 September 1806. Background material and interesting highlights of the expedition are ably recounted in the 51-page Introduction.

R. D. Burroughs, supervisor of education for the Michigan Department of Conservation, has for years been delving into the lore of the Lewis and Clark expedition. He has here done a masterful job of bringing together the natural history material from all available sources. Most of the book (pp. 52–288) consists of extracts, in the explorers' own words, concerning the vertebrates observed (mammals apparently claimed the chief attention). There is also an interesting chapter on the "Quantity and Distribution of Game Killed," where we learn (p. 282) that "It requires 4 deer, or an elk and a deer, or one buffalow to supply us for 24 hours." All is carefully annotated and with appropriate introductory statements. Lewis recorded on 13 June 1805, at the Great Falls of the Missouri:

> I am induced to believe that the Brown, the white and the Grizly bear of this country are the same species only differing in color from age or more properly from the same natural cause that many other anamals of the same family differ in colour. . . . the white one appeared from it's tallons and teeth to be the youngest; it was smaller than the other, and although a monstrous beast we supposed that it had not yet attained it's growth and that it was a little upwards of two years old. . . . the grizly bear we have never yet seen. I have seen their tallons in possession of the Indians and from their form I am preswaded if there is any difference between this species and the brown or white bear it is very inconsiderable. There is no such anamal as a black bear in this open country or of that species generally denominated the black bear. (pp. 61–62.)

Elsewhere we read Clark's notes of 22 December 1804, at Fort Mandan:

> We procured two horns of the anamals the french Call the rock Mountain Sheep. Those horns are not of the largest kind. The Mandans Call this Sheep, Ar-Sar-ta it is about the Size of a large Deer, or a small Elk, its Horns Come out and wind around the head like the horn of a Ram, and the texture is not unlike it, much larger and thicker, perticelarly that part with which they butt. (pp. 171–172.)

These accounts are thoroughly documented by an extensive Bibliography and by Notes to each chapter, serving to interpret and evaluate them in the light of subsequent findings. The Appendix includes Jefferson's original instructions to Lewis, a list of the expedition's supplies and equipment, and copies of several pertinent letters and messages. The terminal Index appears adequate.

This expedition was not noted for its zoological contributions. But if one considers the time when it took place, the vast country covered, often in the face of potentially hostile Indians, the difficulties of transportation, the fact that zoological collecting was really a minor part of its mission, and that both leaders were primarily military men—William Clark an engineer, and Meriwether Lewis with only a casual background in biology—the expedition's achievements gain in stature. The data in the journals are invaluable records. Some specimens survived the rigors of travel and were brought back with the expedition, at considerable pains. The principal lot was dispatched from the winter camp at the Upper Mandan Village in April 1805. Jefferson kept it on display at Monticello for a time, and it was then deposited at the "Philadelphia Museum" established in 1784 by Charles Wilson Peale. After Peale's death in 1820, the museum was incorporated as a stock company, but financial difficulties forced its sale at public auction in 1846, and the specimens were scattered. The natural history material was kept intact and was exhibited at the Masonic Hall in Philadelphia until 1850, when one half was sold to Moses Kimball for the "Boston Museum," and the other to P. T. Barnum for his "American Museum" in New York. This latter material was destroyed by a disastrous fire in 1865. The Kimball portion was transferred to the Boston Society of Natural History in 1893 and 1899; some of the bird specimens were discarded, and the rest sold in 1900 to C. J. Maynard, who stored them in his barn at Newtonville; they were later redeemed by the Boston Society, and in 1914 those that remained were transferred to the Museum of Comparative Zoology. (*See* W. Faxon, Bull. Mus. Comp. Zool., 59: 119–148, 1915; R. Kellogg, Bull. U. S. Nat. Mus., 160: 43, 1932; H. W. Setzer, J. Wash. Acad. Sci., 44: 356–357, 1954.) After this tragic history, it is fortunate that as much as does remains of the Lewis and Clark materials. The present volume casts them into proper perspective and serves to increase our respect for the natural history accomplishments of this unprecedented expedition. This is an attractive, readable book that will enhance the value of any library of natural history or Americana.—Richard H. Manville.

Goodwin, George G. and Arthur M. Greenhall. A REVIEW OF THE BATS OF TRINIDAD AND TOBAGO: DESCRIPTIONS, RABIES INFECTION, AND ECOLOGY. Bull. Am. Mus. Nat. Hist., Vol. 122, Art. 3, pp. 187–302, fig. 1–113, pl. 7–46. 26 June 1961. Price, $4.00.

In this book, 58 named forms of bats from Trinidad, and 17 from Tobago, are reviewed. The synonomy, type locality, range in Trinidad and Tobago, general characters, description, measurements and weights, specimens recorded, general habits, breeding, food, parasites and diseases are given for each form. Eighteen names that have appeared in published lists and in the literature have been changed and brought up to date, and the records on which three species (*Myotis albescens*, *Myotis argentatus* and *Pipistrellus subflavus*) were included in recent lists of Trinidad bats are proved to be erroneous. A line drawing of a front view of the head is presented for almost every species and also, in most instances, drawings of unusual skeletal or other anatomical features. There are excellent photographs, in lateral, dorsal and ventral views, of the skulls of the forms discussed, and of landscapes, habitats and bat roosts on Trinidad and Tobago. Good keys are given for the families, genera, species and subspecies that occur on the islands, and a check list of mammals, other than bats, is included.

Of particular interest is the large amount of first-hand information gathered by Greenhall on the ecology, natural history, diseases and parasites of Trinidad and Tobago bats. Trinidad has had the highest human mortality rate from bites of rabies-infected bats ever recorded anywhere and, consequently, a good deal of interest centers on this problem. There are eight species of Trinidad bats which have been found infected with rabies. According to the authors, rabies suddenly appeared in Trinidad bats in 1925, and the resultant loss of livestock and human lives made farmers and city dwellers alike extremely aware of their bat problem. Rabies in bats is apparently endemic; in Trinidad it reached epidemic proportions between 1925 and 1935, when it caused the deaths of 89 human beings, and livestock losses in the thousands. The authors state that the study of bat behavior may help to predict rabies outbreaks. In fact, the 1958 Annual Report of the Department of Agriculture of Trinidad and Tobago, in analyzing Greenhall's bat studies for that year, predicted an outbreak in 1959, which actually occurred.

The introductory portion of the book contains sections on the history of Trinidad and Tobago, rabies and other infectious diseases in bats, bat control, geography, topography, geology, climate and vegetation of the islands. The book concludes with a Gazeteer of the principal localities and collecting stations on both Trinidad and Tobago, and a bibliography of some 45 publications consulted by the authors. It is one of the most complete and comprehensive studies on tropical American bats published to date, and will be of value to taxonomists, ecologists, parasitologists and medical scientists.—JOHN L. PARADISO.

Banasiak, Chester F. DEER IN MAINE. Game Div. Bull. 6, Dept. Inland Fisheries and Game, Augusta, Maine. Pp. ix + 159, illus. January 1961.

More has been written of deer than of any other American game animal. In Maine, deer have long been not only the principal game species, but a major item in the State's economy. In this exhaustive bulletin, the history of the subject is reviewed back to 1623. But most of the space is devoted to details of a concentrated study of the white-tailed deer begun by the Game Division in 1947, and accelerated in 1953. It is a progress report on matters basic to new game legislation. It considers foods and behavior, populations and distribution, growth and reproduction, hunting pressure, economic considerations, and other information essential for wise management. In recent years, hunters have increased by 70 per cent, one of every four hunters has tagged a deer, and some 40,000 have been harvested annually. Total annual mortality from all causes is estimated at 107,000. Less than 3 per cent of all State lands are closed to hunting. One of these closed areas is Mt. Desert Island, where too many deer exist and hunting has been illegal since 1905. Yet mortality from all causes (malnutrition, automobiles, poaching, dogs, etc.) on this island approaches 1.03 as against a Statewide hunting harvest of 1.3 per square mile. The forest herds of the State have been under-harvested, and future emphasis on hunting in the "big woods" is indicated to remove surpluses from lands populated beyond their carrying capacity and to keep the harvest within the annual increment of the herds.—R. H. M.

Froman, Robert. THE NERVE OF SOME ANIMALS. J. B. Lippincott Co., Phila. 250 pp., illus. by Charles H. Hargens. 17 May 1961. Price, $4.95.

Unfortunately, most animals of which we read in the daiily press are the nonconformists of their kind. They attract attention because of their individualistic traits, their tendency to frustrate mere people by their unprecedented actions. They flout the natural laws of behavior, except for that which has been called the Harvard Law of Animal Behavior: that under carefully controlled conditions animals do exactly as they please. Of these creatures, a dozen tales are here collected—concerning Los Coyotes de Los Angeles, the Owyhee Broomtail (a mustang), Old Dakota Three Toes (a wolf), the Red Ghost (a camel), McGinnis, McGinty & Co. (beavers), and others. The author occasionally takes liberties with the truth that rival the exploits of his subjects, but this we may consider as poetic license. The book is highly readable, witty and entertaining, and it helps to set man back in his proper place.—R. H. M.

Lyman, Charles P. and Albert R. Dawe, *Eds.* MAMMALIAN HIBERNATION: PROCEEDINGS OF THE FIRST INTERNATIONAL SYMPOSIUM ON NATURAL MAMMALIAN HIBERNATION, MAY 13–15, 1959. Bull. Mus. Comp. Zool., Harvard College, Vol. 124, pp. 1–549, illus. November 1960. Price, $3.50 (paper), $4.50 (cloth).

This symposium, sponsored by the Office of Naval Research, under the auspices of the American Institute of Biological Sciences, and held at the facilities of the Massachusetts Institute of Technology, stands as a milestone in the resurgent interest in mammalian hibernation of the last twenty years. Participants included 44 investigators from six countries, who presented 26 papers on recent advances in our knowledge of the mechanics of hibernation. These were followed by a panel discussion of the subject as a whole, and a general discussion. Among speakers familiar to this Society were Bartholomew, Brattstrom, Denyes, Folk, Griffin, Hock, Mayer, Morrison, Musacchia, Pearson, Riedesel and Wimsatt. Animals treated include bats, bears, dormice, ground squirrels, hamsters, hedgehogs, jerboas, jumping mice, marmots—and even birds. Subjects stressed are principally biochemical and physiological, pointing up the need for further ecological studies on these problems which are unique in the warm-blooded mammalian and avian world. This hefty tome will certainly do much to spur on essential research in this entrancing field.—R. H. M.

Orr, Robert T. VERTEBRATE BIOLOGY. W. B. Saunders Co., Phila. Pp. x + 400, 157 figs. 11 May 1961. Price, $7.50.

This concise book would seem an admirable text for a course paralleling the traditional one in comparative anatomy. From the pen of our past-president, who is Curator of Birds and Mammals at the California Academy of Sciences and Professor of Biology at the University of San Francisco, it is derived from his lectures in vertebrate biology at the latter institution. The first chapters offer synoptic treatments of the general characters and major organ systems of the vertebrate classes, but place considerably more emphasis on special characters. In the chapter on Mammals, for instance, are discussions of the mammary glands, dermal glands, hair, teeth, antlers and horns, structural adaptations of the appendages, and a brief characterization of the living orders. The last eight chapters deal with basic principles and theories relating to systematics, distribution, territory and home range, population movements, dormancy, reproduction, growth and development, and population dynamics. In few other places is so much material on all these topics available so conveniently. Each chapter has a generous list of up-to-date references. The illustrations are well chosen and well reproduced, most of them originals. The Index is unusually detailed and carefully prepared. Certainly this authoritative volume will be used to advantage by both students and teachers with an interest not only in the structure of the vertebrates, but in their ways of life as well.—R. H. M.

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COMMENTS AND NEWS

TO ALL CONTRIBUTORS

Authors are reminded that all manuscripts and other matter for the attention of the Editor should now be addressed to Dr. James R. Beer, Dept. of Entomology and Economic Zoology, Univ. of Minnesota, St. Paul 1, Minnesota.

BIOLOGICAL COMMUNICATIONS

At the dedication of its new editorial and executive offices in October 1960, BIOLOGICAL ABSTRACTS invited a dozen prominent biologists and information specialists to participate in a Symposium to discuss ways to improve biological communications. Many constructive ideas were presented, and transcripts have now been published in a 20-page brochure entitled *Biological Communications: theory, structure, function, management.* Copies are available from Biological Abstracts, 3815 Walnut St., Philadelphia 4, Pa.

AUSTRALIAN MAMMAL SOCIETY

At its third general meeting in Brisbane on 26 May 1961, the Australian Mammal Society elected the following office-bearers for the 1961–62 term: *President*, G. B. Sharman; *Vice-President*, W. D. L. Ride; *Secretary*, R. G. Chittleborough; *Treasurer*, J. A. Thomson; *Editor*, J. H. Calaby; *Council Members*, A. K. Lee, A. G. Lyne.

CONFERENCE ON TAXONOMY

Plans are being made for an international conference of experimental biologists interested in the significance to taxonomy and evolution of their research, to be held 5–7 September 1962, with sessions on systematic serology, blood groups and taxonomy, and comparative biochemistry. There will be invited papers and reports, as well as solicited communications. Biologists interested in participating should contact Dr. Charles A. Leone, Dept. of Zoology, Univ. of Kansas, Lawrence.

ALPINE STUDIES

The University of Colorado Museum will entertain proposals from qualified scientists to serve as Visiting Curator for periods up to one year, for the improvement of the collections and their research potential, assuming that such duties will simultaneously be advantageous to the incumbent. The University's study area on Niwot Ridge, west of Boulder, is one spot available for field work. Inquiries should be addressed to Dr. Hugo G. Rodeck, University of Colorado Museum, Boulder.

PREHISTORY OF THE SOUTHWEST

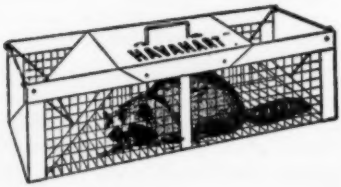
Studies by the Geochronology Laboratories at the University of Arizona, seeking to reconstruct the prehistory of the region, have led to some interesting mammal finds. During the recent field season, in the arid lands near Safford, Arizona, 500,000-year-old fossil remains of six capybara, including two jaw bones, were uncovered. These tropical rodents apparently lived on green vegetation, as do their counterparts today, and reached weights of about 200 pounds. Present-day capybara, although the largest of all rodents, seldom exceed 160 pounds, and do not occur naturally north of Panama. Another recent find, near Pirtleville, Arizona, was the skull of a mammoth with the tusks and two teeth still attached.

DEATHS REPORTED

William H. Brown, 11 May 1961

Ernst Schwarz, 23 September 1961

HAVAHART HUMANE ANIMAL TRAPS



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PERSONAL NOTICES

This space is available to members of the Society for brief notices of interest to mammalogists. Copy should be sent to the Editor by the 10th of the month preceding publication. Rates for single insertion are 25 cents per line or portion thereof. Notices will be continued in each issue unless cancellation is received a month before publication or unless specified in original order. Bills will be rendered by the Secretary–Treasurer following publication.

FOR SALE—*Japanese "Mist" Bat Nets.* Send for price list. W. B. Davis, 254 F.E., College Station, Texas.

KEY TO THE SKULLS OF NORTH AMERICAN MAMMALS, by Bryan P. Glass, has been reprinted and may be ordered from the Research Foundation, Oklahoma State University, Stillwater, Oklahoma. Price $2.00 as in the past.

URGENTLY NEEDED—*Serum of foreign pinnipeds* for a comparative study involving electrophoretic and immunologic work on pinnipeds of the world. Directions for preservation and shipping sent on request; we assume shipping costs. Murray L. Johnson, Museum of Natural History, University of Puget Sound, Tacoma 6, Washington, U. S. A.

FOR *Sherman Live Traps* write H. B. Sherman, P.O. Box 683, De Land, Florida.

ALL-PETS MAGAZINE is written for hobbyists, breeders, fanciers and people engaged in pets for profit; covers all unusual livestock kept as pets, plus aquaria, cage and aviary birds, cats and dogs; subscription $3.50 per year. Manuscripts solicited from ASM members. Established 25 years, circulation world-wide, 80 pages and up monthly. We also publish books on pet livestock; some 80 titles now. National distributors of some 350 books on pets. Write for free book circular to Frank Dittrich, 139 Darling Place, Fond du Lac, Wisconsin.

WANTED—*Correspondents* anywhere with interest in rodents or other small mammals. Also interested in swapping southwestern U. S. species for those from other areas. Niles H. Hagedorn, 44628 N. Gingham Ave., Lancaster, Calif.

NOTICE—Because of research commitments, I am no longer able to collect live desert rodents for commercial sale. Future orders and inquiries should be sent to the *Arizona Biological Supply Company*, 964 Calle Milu, Tucson, Arizona. This company was founded by me, but its expanded activities are now conducted by a group of graduate students at the University of Arizona. They will appreciate your patronage.—Keith E. Justice.

FOR SALE—*North American Faunas* No. 1 to 56 (except 23, 28, 29, 39 and 50), in excellent condition; No. 7, 17, 27 and 49 bound. Also available: *Roosevelt Wild Life Bulletins*, 1923 to 1937, a broken run from Vol. 1, No. 3 to Vol. 7, No. 1. Mrs. Norma C. Williams, 6620 Lee Highway, Arlington 13, Va.

WANTED—*Skulls or heads* of bear, wolf, wolverine, cougar, javelina, etc. I buy most types. Also interested in corresponding and swapping with other collectors. Doug Kenefick, 19 Leander St., Danielson, Conn.

FORTY-FIRST ANNUAL MEETING

FORTY-FIRST ANNUAL MEETING OF THE AMERICAN SOCIETY OF MAMMALOGISTS

12–16 June 1961

The forty-first annual meeting of the American Society of Mammalogists was held at The University of Illinois, Urbana, Illinois, 12–16 June 1961.

The local committee was composed of Donald F. Hoffmeister, Chairman, Robert S. Bader, George Barlow, Harry Henriksen, S. Charles Kendeigh, Robert L. Martin, Iyad Nader, Thomas G. Scott, Hurt H. Shoemaker, Luis de la Torre and James T. Wallace.

PROGRAM

MONDAY, 12 JUNE

2:00–10:00 PM—Registration, Main Lounge, Garner House
8:30 PM—Directors' Meeting, Room 174, Garner House

TUESDAY, 13 JUNE

8:00–11:00 AM—Registration, Auditorium, Law Building
9:00 AM—Morning Session

Welcome: Dr. J. W. Peltason, Dean, College of Liberal Arts and Sciences.
Dr. H. O. Halvorson, Director, School of Life Sciences.
Response: Dr. Stephen D. Durrant, President, American Society of Mammalogists.

1. Studies of energy flow in *Sigmodon hispidus*. F. B. Golley, University of Georgia, Athens.
2. Relation of population density to physiological condition of wild meadow voles. Garrett C. Clough, University of Wisconsin, Madison.
3. Differences in reproduction between two populations of snowshoe hares. Janet Newson, Ontario Agricultural College, Guelph.
4. The effect of population exploitation on woodchuck populations. F. H. Bronson and D. E. Davis, Pennsylvania State University, University Park.
5. Structure and growth of a free-ranging population of rhesus monkeys. Carl B. Koford, National Institutes of Health, Humacao, Puerto Rico.

10:35 AM—Group Photograph, north side, Law Building

6. Insecticide residues in big game animals. Richard E. Pillmore, U. S. Fish and Wildlife Service, Denver, Colorado.
7. Effects of herbicide on rodent populations in western Colorado. Richard M. Hansen, Colorado State University, Fort Collins.
8. Review of herbicides and pesticides in relation to mammal populations in the eastern United States. Willard D. Klimstra, Southern Illinois University, Carbondale.
9. Some observations on mammals exposed to field applications of chlorinated hydrocarbons. Thomas G. Scott, Illinois Natural History Survey, Urbana.

1:00 PM—Afternoon Session

10. The Persian fallow deer: present status and threat of speedy extermination. Charles A. Reed, University of Illinois School of Pharmacy, Chicago.
11. Distribution of the least weasel, *Mustela rixosa*, in Ohio. Ralph W. Dexter, Kent State University, Kent, Ohio.
12. Mammalogy in Manitoba. Charles Buckner, Winnipeg, Manitoba.

13. A new species of mouse (*Peromyscus*) from northwestern Veracruz, Mexico. E. Raymond Hall and Ticul Alvarez, University of Kansas, Lawrence.
14. Late Pleistocene-Recent mammalian fauna of Isleta Cave, New Mexico. Arthur H. Harris and James S. Findley, University of New Mexico, Albuquerque.
15. Baculum development in the red-backed vole. Alan B. Sargeant, University of Minnesota, St. Paul.
16. The marine mammals of the Cape Thompson region, Alaska. Murray L. Johnson, Burton T. Ostenson and Myron L. Barbour, University of Puget Sound and Pacific Lutheran University, Tacoma, Washington.
17. Changes in sex and age ratios, and body weights of the snowshoe hare, *Lepus americanus*. A. de Vos and R. M. Newson, Ontario Agricultural College, Guelph.
18. New data on the biology of the dwarf shrew, *Sorex nanus*. Robert S. Hoffman and Richard D. Taber, Montana State University, Missoula.
19. Life history study of the desert woodrat. Robert C. Stones, Purdue University, Lafayette, Indiana.
20. Notes on *Sorex longirostris* in Indiana. Russell E. Mumford, Purdue University, Lafayette, Indiana.
21. Biology of the impala in Southern Rhodesia. Raymond F. Dasmann, University of California, Berkeley.

6:00 PM—Dinner, Ballroom, Illini Union

Films: "The giraffe in South Africa," Anne Dagg, University of Waterloo, Waterloo, Ontario
"Baboon behavior," University of California.

9:00 PM—Open House and Smoker, Museum of Natural History, Natural History Building

WEDNESDAY, 14 JUNE

8:30 AM—Morning Session

22. Population ecology of the meadow mouse, *M. montanus*. E. L. Hansen, Oregon State College Experiment Station, Klamath Falls.
23. Natural history notes on *Macrotus californicus*. Gordon R. Bradshaw, The Citadel, Charleston, South Carolina.
24. Results of three years' banding in a *Myotis lucifugus* colony in Indiana. James B. Cope and W. Wilson Baker, Earlham College, Richmond, Indiana.
25. Seasonal populations and movements of *Myotis grisescens* in Kentucky and some surrounding states. John S. Hall, Albright College, Reading, Pennsylvania, and Nixon Wilson, Purdue University, Lafayette, Indiana.
26. Preliminary studies on some unique aspects of a population of bats in a Vermont cave. W. H. Davis and H. B. Hitchcock, Middlebury College, Middlebury, Vermont.
27. The migration and distribution of Ozark Plateau bats of the genus *Myotis*. Richard F. Myers, Central Missouri State College, Warrensburg.

10:15 AM—Annual Business Meeting
1:00 PM—Afternoon Session

28. Distribution of the black-tailed jackrabbit, *Lepus californicus*, in eastern Texas. Robert L. Packard, Stephen F. Austin State College, Nacogdoches, Texas.
29. Some responses of *Microtus* to snap-trapping procedures. Kyle R. Barbehenn, National Institute of Mental Health, Bethesda, Maryland.
30. Botfly parasitism in a local population of the white-footed mouse. Stanley C. Wecker, University of Michigan, Ann Arbor. (This paper received the A.S.M. award.)

31. A technique for the measurement of home ranges in *Microtus pennsylvanicus*, using I^{131}. Arthur G. Johanningsmeier, Purdue University, Lafayette, Indiana.
32. The American gray squirrel in Great Britain. Frederick S. Barkalow, Jr., North Carolina State College, Raleigh.
33. Echolocation in shrews? Edwin Gould, Tulane University, New Orleans, Louisiana.
34. Social behavior and bioenergetics in relation to density of house mice. Robert H. Catlett, University of California, Davis. (This paper received the A. B. Howell award.)
35. Biomes and biociations. S. Charles Kendeigh, University of Illinois, Champaign.
36. Food and habitat preference in the lemmings, *Lemmus trimucronatus* and *Dicrostonyx groenlandicus*. Daniel Q. Thompson, Ripon College, Ripon, Wisconsin.

6:00 PM—Cocktail hour, Urbana Country Club
7:00 PM—Annual Banquet, Urbana Country Club
9:00 PM—Film by Dr. S. Glidden Baldwin at Law Auditorium: "An amateur's view of mammals around the world."

THURSDAY, 15 JUNE

8:30 AM—Morning Session

37. Ethological isolating mechanisms in kangaroo rats. Bernard B. Butterworth, University of Wichita, Wichita, Kansas.
38. The seasonal occurrence of *Tadarida mexicana* in southern Mexico. Dilford C. Carter, A. and M. College of Texas, College Station.
39. White-sided jackrabbits of Mexico. Sydney Anderson, American Museum of Natural History, New York, and Abbot S. Gaunt, University of Kansas, Lawrence.
40. The carnivorous marsupials of New Guinea. Hobart M. Van Deusen, American Museum of Natural History, New York.
41. Distribution of montane mammals in the Southwest. James S. Findley, University of New Mexico, Albuquerque.
42. A simple method for graphically representing differentiation. William Lidicker, Jr., University of California, Berkeley.

10:45 AM—Final Business Session
1:00 PM—Afternoon Session

43. Nocturnalism in three species of desert rodents. Keith E. Justice, Tucson, Arizona.
44. A comparison of the water balance of *Microtus pennsylvanicus* and *M. ochrogaster*. Lowell L. Getz, University of Michigan, Ann Arbor.
45. Cave and body temperatures of Mexican free-tailed bats. Clyde F. Herreid II, Pennsylvania State University, University Park.
46. Comparison of water consumption in several species of small mammals. Harvey L. Gunderson, University of Minnesota, Minneapolis.
47. Fat deposition in *Citellus lateralis* and *Eutamias* spp. E. W. Jameson, Jr. and R. A. Mead, University of California, Davis.
48. Bioaccumulation of radioisotopes by mammals in a radioactive environment. Paul B. Dunaway, Oak Ridge National Laboratory, Oak Ridge, Tennessee.
49. The use of discriminant functions in studies of geographic variation. D. P. Snyder, University of Massachusetts, Amherst.
50. Mammal research of the Canadian Wildlife Service. W. E. Stevens, Canadian Wildlife Service, Ottawa, Ontario.
51. Population changes of carnivores in some coyote control areas. Weldon B. Robinson, U. S. Fish and Wildlife Service, Denver, Colorado.

52. Notes on the occurrence of certain mutations in Michigan white-tailed deer. Lawrence A. Ryel, Lansing, Michigan.
53. The use of miniature radios in tracking mammals. William W. Cochran and Rexford D. Lord, Jr., Illinois Natural History Survey, Urbana.
54. Behavior among elephant seals in Vincennes Bay, Antarctica. Richard G. Miller, Carson City, Nevada.

5:00 PM—Illinois Natural History Survey: conducted demonstration at wildlife research areas, Allerton Park.

7:00 PM—Barbecue Dinner at University of Illinois Allerton Park, and tour of formal gardens.

DIRECTORS' MEETING

The Directors of the American Society of Mammalogists met on 12 June 1961 in Garner House, University of Illinois, Urbana, at 8:36 PM. The minutes of the previous meeting were read and approved. Removal of 40 names from the membership roll for nonpayment of dues was approved; 64 resignations were accepted. Requests from Charles Mohr, Oliver Filley and Leo Couch for Emeritus Membership were approved. The financial report of the Secretary-Treasurer, and that of the Auditor, were approved. Total disbursements for 1960 amounted to $15,055.48. Income during the same time amounted to $16,751.35. The report of the Trustees was approved. Net gain in market value of investments during 1960 amounted to $21,653.00. Transfer of $3,434.34 from the Endowment Fund, and $997.22 from the J. A. Allen Memorial Fund, to the Secretary-Treasurer for publication of the *Journal* was approved. The Committee on Honorary Memberships reported no nominations. Proposals to prepare and present suitable certificates to Honorary Members, and less elaborate certificates to Life Members, were approved. Transfer of $1,400.00 from life membership payments to the Trustees for investment was approved.

The following budget was approved for 1961:

Expenses of the Journal of Mammalogy	$11,000.00
Expenses of the Executive Office	2,000.00
Editorial expenses	700.00
Membership Committee expenses	65.00
Index Committee expenses	35.00
Honoraria	200.00
AIBS	200.00
Zoological Record	100.00
IUCN	50.00
Contingent Fund	150.00
Total	$14,500.00

It was agreed that of the two honoraria awarded annually, one should be designated the A. B. Howell Award, and one the A.S.M. Award, with no question of relative merit involved. The Index Committee report was approved. Price of the new index for Volumes 31–40 of the *Journal* was set at $5.00 per copy, with 20% discount allowed to members. Bryan P. Glass was reappointed Secretary-Treasurer. W. B. Davis was appointed Trustee in place of D. D. Davis, whose term expires. R. T. Orr reported that a special committee, appointed to seek a replacement for R. H. Manville, who had expressed a wish to relinquish the editorship, had not yet been able to secure a replacement. Manville agreed to carry on until a suitable replacement might be found. The meeting was adjourned at 12:27 AM.

SPECIAL DIRECTORS' MEETING

A special meeting of the Directors was called by President Durrant at 8:06 AM on 15 June 1961. R. T. Orr reported that James R. Beer had agreed to assume the editorship, and his appointment was approved. He was instructed to arrange with Manville for transfer of duties. Setting aside of not more than $250.00 in the Contingency Fund to assist foreign mammalogists in attending our meetings was approved. The meeting adjourned at 8:32 AM.

ANNUAL BUSINESS MEETING

The first session of the Annual Business Meeting was called to order at 10:24 AM with 114 members in attendance. The minutes of the previous meeting were read and approved. The names of 183 applications for membership received between 1 April 1960 and 31 March 1961, and approximately 30 received since the latter date, were approved for membership. The deaths of eight members were announced: Paul Bartsch, Angel Cabrera (Honorary Member), Larry Commissaris, Harold Haecker, Wetmore Hodges (Life Member), Leonard Llewellyn, William Mann (Life Member) and Walter Scott.

The following statistical summary was presented:

	Minus	*Plus*
Membership		
Changes since last report:		
Nominees		172
Resignations	64	
Deaths reported	8	
Dropped, delinquent	41	
	113	172
Net gain		79
Status of members as of 31 March 1961:		
Honorary		7
Life		152
Honorary and Life		3
Emeritus		12
Annual		1,649
Total		1,823
Subscriptions		633
New		88
Not renewed		64
Net gain		24
Mailing list as of 31 March 1961:		
Total membership		1,823
Members not receiving *Journal*		181
Members receiving *Journal*		1,642
Total paid subscriptions		633
Total mailing list		2,275

Removal of 40 names from the membership list for nonpayment of dues was approved. The report of the Secretary-Treasurer on the status of memberships and subscriptions, and the financial report, were approved. The report of the Auditor was read and approved. The report of the Trustees was approved. The amendment to the bylaws, relative to selecting meeting-places more than one year in advance, was approved in the form published in Volume 42 (1),

p. 144, of the *Journal*. Glass proposed an amendment to Art. II, Sec. 2, first sentence of the bylaws to read in part: "Any person may become a Member upon recommendation of one Member . . . ." The proposal was approved, in principle, for future action in accordance with proper procedure on amendments. The following elective officers were elected: S. D. Durrant, President; Emmet T. Hooper and Donald F. Hoffmeister, Vice-Presidents; Randolph L. Peterson, Recording Secretary. Rollin H. Baker, Richard G. Van Gelder, F. S. Barkalow, Richard M. Hansen and Viola S. Schantz were elected Directors for two-year terms. J. Knox Jones was elected to fill the unexpired portion of Hoffmeister's term. Reports of Committees on Bibliography, Conservation of Land Mammals, Honoraria, Marine Mammals, International Relations and the Editorial and Index Committees, were presented and approved. Meeting adjourned at 12:03 PM.

FINAL BUSINESS SESSION

The final business session convened at 10:57 AM on 15 June, with a total of 106 members present. The appointment of J. R. Beer as Editor of the *Journal* was announced, his duties to begin with the first issue of Volume 43. Reports of the Membership and Nomenclature Committees, and of representatives to AIBS and AAAS, were presented and approved. E. R. Hall reported on the International Symposium on Theriological Methods held in Brno, Czechoslovakia, in 1960.

The Resolutions Committee presented the following resolution, which was approved:

WHEREAS, The 41st Annual Meeting of the American Society of Mammalogists, convened 12 to 16 June 1961, at the University of Illinois in Urbana, has been characterized by great productivity, pleasant associations, and profitable proceedings; and

WHEREAS, The facilities made available and the activities provided have enhanced the pleasant entertainment and hospitable reception enjoyed by the members of the Society, their families and friends; now, therefore, be it

Resolved, That the sincere thanks and appreciation of the Society are extended to Donald F. Hoffmeister, Chairman, and to the other members of the committee on arrangements, to Thomas G. Scott and Harlow B. Mills, and to the ladies of the local committee, all of whom gave so generously of their time and talents in making this meeting distinctive in the history of the Society. These expressions of gratitude are also extended to the organizations and institutions which generously aided in the planning and execution of this most pleasing and profitable conference: the Museum of Natural History, the Illinois Natural History Survey, the Krannert Art Museum, the Department of Zoology, the School of Life Sciences, and other cooperating units of the University of Illinois.

Sydney Anderson presented the following resolution:

The collections of mammals in North America were censused by A. B. Howell in 1923, at which time about 410,000 specimens were reported. The number of specimens had increased to more than 939,000 by 1945, as reported by J. K. Doutt, A. B. Howell and W. B. Davis in the *Journal of Mammalogy*. The status of collections in other countries is also of interest. A new census is warranted now because of its future historical interest and because information about collections will aid users. Collections have expanded; new collections have been assembled; and collections that were privately owned have been deposited in public institutions. Therefore, I move:

(1) That the President appoint a committee of three members of the Society who are in attendance at this annual meeting to approve the form of a questionnaire to be used in obtaining information regarding the current status of collections of mammals in North America, and perhaps a different questionnaire to obtain information on collections in other continents, and to compile the information obtained in a form suitable for publication in the *Journal of Mammalogy*;

(2) That the committee shall serve until the compilation of information shall have been published, and no longer; and

(3) That the committee shall be known as the Temporary Committee on Collections.

The resolution was approved. The following members were appointed to compose the Temporary Committee on Collections: J. K. Doutt, J. S. Findley and S. Anderson, Chairman. A second resolution by Anderson pertaining to the microfilming of museum catalogues of mammal collections was tabled.

Middlebury College, Middlebury, Vermont, was selected as the meeting place for 1962, and the University of New Mexico, Albuquerque, for 1963, exact times to be announced later. The meeting adjourned at 12:07 PM.

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(Prepared by the Index Committee)

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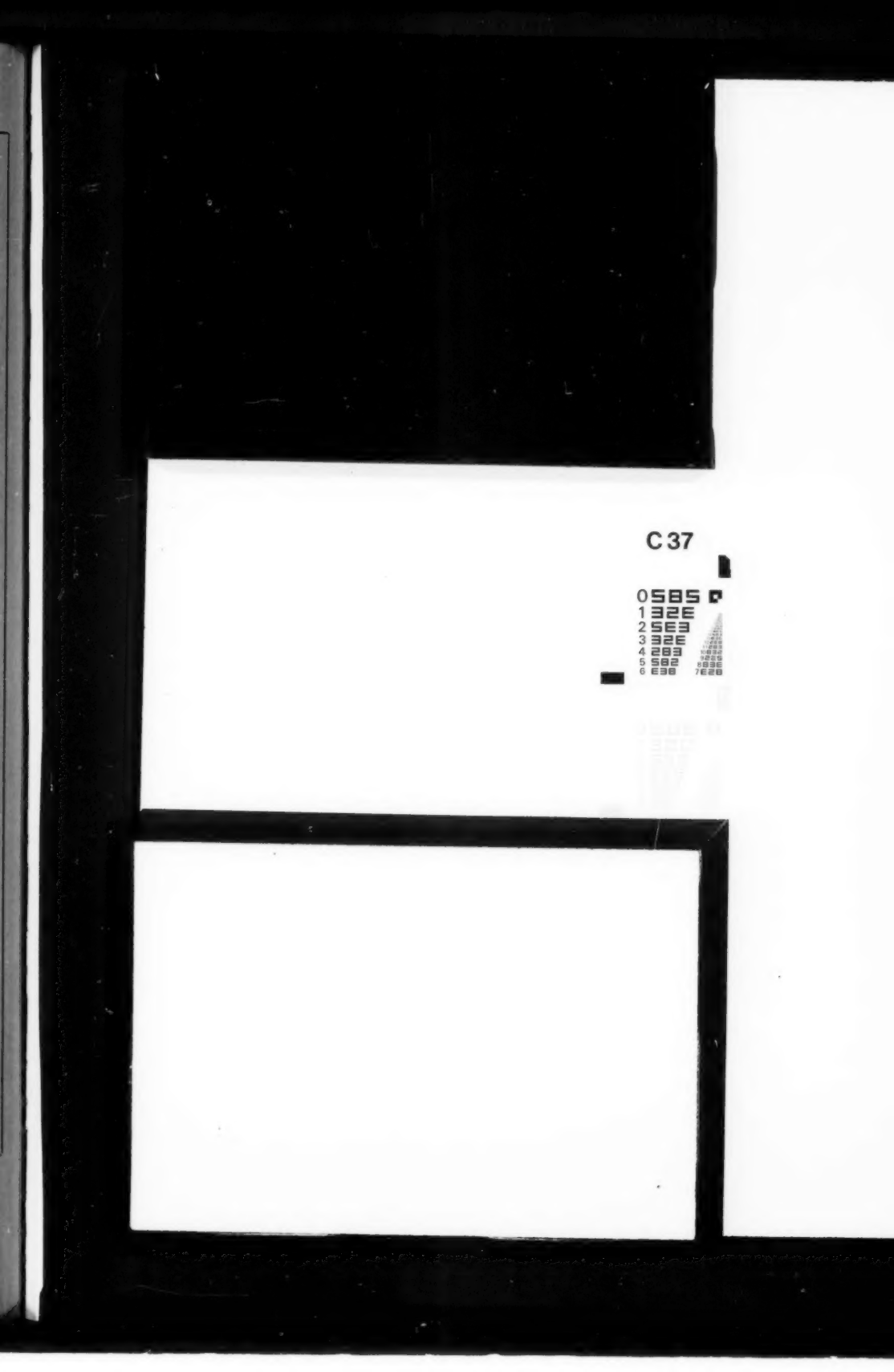
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